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Under contract to the EPA, Radian developed an air toxics emission inventory for the state of Alaska. This inventory focuses on both point (i.e., specifically identified facilities) and area sources. The area source inventory does not identify facilities, but instsead consists of aggregated emission totals for a geographic area. Activity data were obtained for the time periods ranging from 1979 to 1986. Included in the report are exact sources of information and the time periods for which they were derived, and a summary of point and area source emissions by source type. Also included are tables of data by air toxic compound and a detailed list of the point source emissions by source. Threshold limit values were used to rank the emission sources and the results are tabulated.

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AIR TOXICS TECHNICAL ASSISTANCE FOR THE STATE OF ALASKA

FINAL REPORT

Contract No. 68-02-3899
Work Assignment 81

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March 30, 1987

TABLE OF CONTENTS

Section Page

1. Introduction.......... 1-1

2. Summary.......... 2-1

3. Recommendations for Inventory Refinement.......... 3-1
    Activity Data.......... 3-1
    Residential Wood Combustion.......... 3-1
    Airport Emissions.......... 3-1
    Slash Burning and Forest Fires.......... 3-2
    Municipal Wastewater Treatment.......... 3-2
    Asphalt Distribution and Usage.......... 3-2

4. Identification of Air Toxics Emission Sources.......... 4-1
    Facilities in the Point Source Emission Inventory.......... 4-1
    Information Used to Identify Point Sources of Air Toxics.......... 4-4
    Information Used to Identify Area Sources of Air Toxics.......... 4-7

5. Survey of Sources.......... 5-1
    Prioritization of Sources for Survey.......... 5-1
        Survey Approach.......... 5-3
    Summary of Survey Results.......... 5-3
        Autobody Paint Shops.......... 5-3
        Battery Manufacturing.......... 5-5
        Cooling Towers.......... 5-5
        Electroplating.......... 5-5
        Ethylene Oxide Sterilization.......... 5-5
        Industrial Incineration.......... 5-5
        Military Facilities.......... 5-5
        Paint Manufacturing.......... 5-6
        Sewage Sludge Incineration.......... 5-6

6. Estimation of Air Toxics Emissions.......... 6-1
    Point Source Emission Estimates.......... 6-1
        Airport Operations.......... 6-2
        Asphalt Cement (Hot Mix) Plants.......... 6-4
        Barrel Burning.......... 6-4
        Battery Manufacturing.......... 6-4
        Chemical Manufacturing.......... 6-6
        Combustion Sources.......... 6-6
        Cooling Towers.......... 6-7
        Dry Cleaning.......... 6-8
        Electroplating.......... 6-8
        Ethylene Oxide Sterilizers.......... 6-9

TABLE OF CONTENTS (Continued)

Section Page

6. (cont.) Gasoline Evaporation.................................. 6-9
Industrial Incineration.................................6-10
Municipal Solid Waste Incineration......................6-10
Paint Manufacturing.....................................6-10
Portland Cement Manufacturing...........................6-11
Pulp and Paper Mills....................................6-11
Refinery Fugitives......................................6-11
Sewage Sludge Incineration..............................6-14
Surface Coating...6-15
Area Source Emission Estimates..............................6-16
Asphalt Distribution and Usage..........................6-16
Asphalt Cement (Hot Mix)............................6-16
Cutback Asphalts....................................6-16
Emulsified Asphalts.................................6-18
Dry Cleaning..6-18
Mobile Sources..6-18
Pesticide Application...................................6-20
Petroleum Marketing.....................................6-20
Residential Wood Combustion.............................6-24
Slash Burning and Forest Fires..........................6-26

7. Ranking of Point and Area Sources.................................. 7-1
Ranking Methodology.. 7-1
Ranking Results.. 7-5

8. Source Testing and Ambient Air Monitoring of Air Toxics............ 8-1
Source Testing Techniques.. 8-1
Organic Source Testing....................................... 8-1
Inorganic Source Testing..................................... 8-2
Ambient Air Monitoring Techniques................................ 8-2
Organic Monitoring... 8-2
Inorganics Monitoring.. 8-8
Analytical Techniques.. 8-8
Organics Analysis.. 8-8
Inorganics Analysis..8-11
Quality Control..8-11

9. References for Emission Inventory.................................. 9-1

Appendix A - Point Source Emission Estimates.......................... A-1
Appendix B - Emission Factor Documentation............................ B-1
Appendix C - Area Source Emission Estimates........................... C-1
Appendix D - Surface Coating VOC Speciation Data....................... D-1
Appendix E - Detailed Listing of Point Source Ranking.................. E-1
Appdenix F - Air Toxics Questionnaires................................ F-1
Appendix G - Emission Source Categories Associated with
Selected Non-Criteria Pollutants...................... G-1

LIST OF TABLES

Table		Page
2-1	Summary of Air Toxics Emission Estimates by Emission Source Type for Point and Area Sources in Alaska........	2-2
2-2	Summary of Air Toxics Emission Estimates by Pollutant for Point and Area Sources in Alaska..................	2-7
2-3	Point Source Categories Ranked According to Relative Health Risk..	2-12
2-4	Area Source Categories Ranked According to Relative Health Risk..................................	2-15
4-1	Criteria for Inclusion of Facilities on the List of Air Toxics Point Sources.................................	4-2
4-2	Potential Air Toxics Emission Source Types Not Included on the List of Air Toxics Point Sources..................	4-5
4-3	Fifty-Six Selected Non-Criteria Pollutants...............	4-6
5-1	Prioritized List of Emission Sources for Survey...........	5-2
5-2	Percentage of Surveys Returned..........................	5-4
6-1	Percentage of Total PAH Associated with Soot Particles as a Function of Flue Gas Temperature....................	6-3
6-2	Total Hydrocarbon Emissions by Airport and Plane Type.....	6-5
6-3	VOC Emissions Estimates for Alaskan Petroleum Refineries..	6-12
6-4	Estimated Emissions for Asphalt Distribution and Usage....	6-17
6-5	Perchloroethylene Emission Estimates for Dry Cleaning.....	6-19
6-6	Estimated Mobile Source Emissions for Gasoline Consumption..	6-21
6-7	Estimated Mobile Source Emissions for Diesel Consumption..	6-22
6-8	Estimated Pesticide Use in Alaska, 1984..................	6-23
6-9	Estimated Emissions for Petroleum Marketing...............	6-25
6-10	Summary of Estimated Pollutant Emissions from Residential Wood Combustion............................	6-27

LIST OF TABLES (Continued)

Table		Page
6-11	POM and Manganese Emissions from Slash Burning	6-28
7-1	Toxicity Weighting Data for Air Toxics Emitted In Alaska	7-3
7-2	Point Source Categories Ranked According to Relative Health Risk	7-6
7-3	Facilities with Ranking Factors Greater than 5,000	7-9
7-4	Ranking Factors for Area Source Categories	7-10
8-1	Summary of Source Testing Methods for Organic Air Toxics	8-3
8-2	Summary of Ambient Sampling and Analysis Methods for Toxic Organics	8-5
8-3	Summary of Toxic Organic Compounds for Which Ambient Sampling and Methods have been Evaluated	8-7
8-4	Summary of Analytical Methods for Organic Air Toxics	8-9
B-1	Summary of Emission Factors for Chrome Plating	B-10
C-1	Asphalt Use in Alaska	C-3
C-2	Wood Use Survey Results	C-5
C-3	Number of Occupied Year-Round Housing Units for Five Alaska Boroughs - 1980	C-6
C-4	Summary of Estimated Residential Wood Combustion Rates	C-9
C-5	Summary of Estimated Pollutant Emissions from Residential Wood Combustion	C-10
C-6	POM and Manganese Emissions from Slash Burning	C-12

SECTION 1

INTRODUCTION

Due to public concerns regarding the possible hazards associated with air toxics, state and local air agencies are being encouraged by the EPA to develop and strengthen their own air toxics program. State and local programs are generally designed to complement the federal air toxics program.

The development of an inventory of air toxics is a logical first step in an air toxics program. Once the various sources of air toxics have been identified and quantified, prioritization of individual contaminants and source categories can be performed. Ambient monitoring, source sampling, and emission control strategies can be developed for the important contaminants and source categories.

Radian, under contract to EPA, has developed an air toxics emission inventory for the state of Alaska. This inventory identifies point and area sources of air toxics and quantifies emissions where possible. The emission sources have been ranked in terms of the relative health risk that they represent. Source testing and ambient air monitoring guidance are also presented.

The structure of this document is listed below:

- Section 2.0 summarizes the emission estimates and presents the ranked list of sources;
- Section 3.0 presents recommendations for future inventory modifications that are beyond the scope of this initial inventory;
- Section 4.0 presents the methodology used to identify sources of air toxics;
- Section 5.0 discusses the survey approach and results used to help compile the inventory;
- Section 6.0 documents the data, information, and methodologies used to estimate emissions,
- Section 7.0 presents the methodology used to rank the sources in terms of the relative health risk that their air toxics emissions represent; and
- Section 8.0 presents an overview of source testing and ambient air monitoring for air toxics.

SECTION 2

SUMMARY

Under contract to the EPA, Radian developed an air toxics emission inventory for the state of Alaska. This inventory focuses on both point (i.e., specifically identified facilities) and area sources. The area source inventory does not identify facilities, but instead consists of aggregated emission totals for a geographic area. The following activities were performed in compiling the inventory:

- a literature review was conducted,
- a list of air toxics point sources was developed,
- a survey of facilities was conducted through use of questionnaires, and
- air toxics emissions were estimated for point and area sources.

The primary result of these activities was the development of an air toxics emission inventory. The inventory is based on a variety of sources of information. Activity data were obtained for time periods ranging from 1979 to 1986. The exact sources of information and the time periods for which they were derived are discussed in Section 5 and 6. A summary of point and area source emissions by source type for the state of Alaska is presented in Table 2-1. This same information is presented by air toxic compound in Table 2-2. A detailed list of the point source emissions by source type is presented in Appendix A.

Threshold limit values were then used to rank the emission sources. This ranking of sources will allow EPA and state officials to focus on those sources that represent the greatest health risk to the general population. Results of the ranking procedure are summarized in Tables 2-3 and 2-4.

In reviewing the point source emission inventory and the ranking of sources, the reader must be cautious in drawing conclusions. In particular, caution should be taken in drawing conclusions about the health risk that a particular air toxics emission source represents. A quantitative evaluation of the relative health risks that different air toxics emission sources represent cannot be made from the emission inventory and ranking procedure for the following reasons:

- the uncertainty that exists in some of the air toxics emission estimates is large;

- some of the emission estimates may change in the near future (for example, new regulations that mandate decreasing the lead content in gasoline will result in significantly lower emissions of EDB and EDC from gasoline evaporation); and

- pollutant exposures (i.e., the ambient concentrations experienced by the general population) which are needed to quantitatively evaluate risk have not been calculated.

TABLE 2-1.

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY EMISSION SOURCE TYPE FOR POINT AND AREA SOURCES IN ALASKA

Emission Source Type	Pollutant	Emissions (lbs/yr)
Airport Operations	PAH	N/A
	Dioxins	N/A
	Formaldehyde	N/A
	Xylene	120,000
	Benzene	5,900
Asphalt Distribution & Usage	Benzene	2,900
	Formaldehyde	150
	PAH	29
	Toluene	35,000
	Xylene	68,000
Battery Manufacturing	Lead	130
	Arsenic	N/A
	Cadmium	N/A
	Manganese	N/A
Coal Combustion	Arsenic	770
	Beryllium	23
	Cadmium	230
	Chromium	660
	Radionuclides	1,300
	Formaldehyde	1,600
	Manganese	2,200
	Mercury	10
	Nickel	660
	PAH	12
Cooling Towers	Chromium	0
	Nickel	0
	Chloroform	29,000
Distillate Oil Combustion	Chromium	260
	Formaldehyde	1,500
	Manganese	150
	Nickel	5,200
	PAH	8
	Radionuclides	N/A

Continued

TABLE 2-1. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY EMISSION SOURCE TYPE FOR POINT AND AREA SOURCES IN ALASKA

Emission Source Type	Pollutant	Emissions (lbs/yr)
Dry Cleaners (Area Sources)	Perchloroethylene	300,000
Dry Cleaners (Point Sources)	Perchloroethylene	52,000
	Freon 113	N/A
Electroplating	Chromium	8
	Nickel	<0.1
Ethylene Oxide Sterilization	Ethylene Oxide	1,800
Gasoline Evaporation	Benzene	81,000
	Ethylene Dibromide	6
	Ethylene Dichloride	44
Hot Mix Asphalt Production	Benzene	3,900
	Formaldehyde	220
	PAH	38
Mobile Sources	Benzene	420,000
	Formaldehyde	1,500,000
	Toluene	1,600,000
	Xylene	39,000
	POM	N/A
Municipal Solid Waste Incineration	Arsenic	17
	Beryllium	0.4
	Cadmium	110
	Chromium	680
	Lead	2,600
	Manganese	260
	Nickel	570
	PAH	5
	Furans	<1
	PCB	<1
	Dioxins	<1

Continued

TABLE 2-1. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY
EMISSION SOURCE TYPE FOR POINT AND AREA SOURCES IN ALASKA

Emission Source Type	Pollutant	Emissions (lbs/yr)
Paint Manufacturing	Toluene	N/A
Pesticide Application	Formaldehyde	16,000
Petroleum Marketing	Benzene	49,000
	EDB	1.8
	EDC	12
	Toluene	33,000
	Xylene	9,900
Portland Cement Manufacturing	Chromium	0.2
	Nickel	0.1
Pulp & Paper Mills	Chloroform	63,000
Reciprocating Diesel Engine	Chromium	240
	Manganese	140
	Nickel	4,700
	PAH	48
	Formaldehyde	3,400
Refinery Fugitives	Benzene	6,900
	Toluene	20,000
	Xylene	30,000

Continued

TABLE 2-1. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY
EMISSION SOURCE TYPE FOR POINT AND AREA SOURCES IN ALASKA

Emission Source Type	Pollutant	Emissions (lbs/yr)
Residential Wood Combustion	Acetaldyhyde	20,000
	Benzene*	3,300
	Cresols	47,000
	Dioxins*	<0.1
	Formaldehyde	41,000
	Phenol	59,000
	POM	41,900
Residual Oil Combustion	Chromium	2
	Formaldehyde	9
	Manganese	1
	Nickel	38
	PAH	<0.1
	Radionuclides	N/A
Sewage Sludge Incineration	Arsenic	2
	Beryllium	N/A
	Cadmium	2
	Chromium	8
	Lead	27
	Manganese	N/A
	Mercury	2
	Nickel	8
	PAH	11
	Dibenzofuran	9
Slash Burning**	Manganese	780
	POM	15,000
Turbine Diesel Engine	Chromium	1,100
	Manganese	620
	Nickel	22,000
	PAH	31
	Formaldehyde	23,000

Continued

TABLE 2-1. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY
EMISSION SOURCE TYPE FOR POINT AND AREA SOURCES IN ALASKA

Emission Source Type	Pollutant	Emissions (lbs/yr)
Waste Oil Combustion	Arsenic	35
	Cadmium	11
	Chromium	54
	Lead	540
	Manganese	N/A
	Nickel	N/A
	PAH	22
	Formaldehyde	4,100
Wood Combustion	Aldehydes	N/A
	PAH	30,000
Waste Water Emissions***	Chloroform	63,000

N/A - Emission estimates are not available at this time. A discussion of the information that is needed to estimate emissions is presented in Section Six.

* Emission estimates for these species only include the contributions from wood-burning stoves; emission factors for fireplaces were not available.

** These estimates are for the Fairbanks and Anchorage areas only.

*** These estimates are for pulp and paper mills.

TABLE 2-2.

SUMMARY OF AIR TOXICS EMISSION ESTIMATES BY POLLUTANT FOR POINT AND AREA SOURCES IN ALASKA

Pollutant	Emission Source Type	Emissions (lb/yr)
Acetaldehydes	Industrial Wood Combustion	N/A
	Residential Wood Combustion	20,000
Arsenic	Battery Manufacturing	N/A
	Coal Combustion	780
	Municipal Waste Incineration	17
	Sewage Sludge Incineration	2
	Waste Oil Combustion	35
Benzene	Airport Operations	5,900
	Asphalt Distribution Usage	2,900
	Gasoline Evaporation	81,000
	Hot Mix Ashpalt Production	3,900
	Mobile Sources	420,000
	Petroleum Marketing	49,000
	Refinery Fugitives	6,900
	Residential Wood Combustion*	3,300
Beryllium	Coal Combustion	23
	Municipal Waste Incineration	0.4
	Sewage Sludge Incineration	N/A
Cadmium	Battery Manufacturing	N/A
	Coal Combustion	230
	Municipal Waste Incineration	110
	Sewage Sludge Incineration	2
	Waste Oil Combustion	11
Chromium[(a)]	Chrome Plating	8
	Coal Combustion	670
	Cooling Towers	0
	Distillate Oil Combustion	260
	Municipal Waste Incineration	680
	Reciprocating Diesel Engine	240
	Residual Oil Combustion	2
	Portland Cement Manufacturing	0.2
	Sewage Sludge Inceration	8
	Turbine Diesel Engine	1,100
	Waste Oil Combustion	54

TABLE 2-2. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES
BY POLLUTANT FOR POINT AND AREA SOURCES IN ALASKA

Pollutant	Emission Source Type	Emissions (lb/yr)
Chloroform	Cooling Towers	29,000
	Pulp and Paper Mills	63,000
Cresols	Residential Wood Combustion	47,000
Dibenzofuran	Municipal Solid Waste Incineration	<1
	Sewage Sludge Incineration	9
Dioxins	Airport Operations	N/A
	Municipal Waste Incineration	<1
	Residential Wood Combustion	<1
Ethylene Dibromide	Gasoline Evaporation	6
	Petroleum Marketing	1.8
Ethylene Dichloride	Gasoline Evaporation	44
	Petroleum Marketing	12
Ethylene Oxide	Ethylene Oxide Sterilizers	1,600
Formaldehyde	Airport Operations	N/A
	Asphalt Distribution & Usage	150
	Coal Combustion	1,800
	Distillate Oil Combustion	1,500
	Hot Mix Asphalt Production	220
	Mobile Sources	1,500,000
	Pesticide Application	16,000
	Reciprocating Diesel Engine	3,400
	Residential Wood Combustion	41,000
	Residual Oil Combustion	9
	Turbine Diesel Engine	23,000
	Waste Oil Combustion	41,000

TABLE 2-2. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES
BY POLLUTANT FOR POINT AND AREA SOURCES IN ALASKA

Pollutant	Emission Source Type	Emissions (lb/yr)
Freon 113	Dry Cleaning	N/A
Furans	Municipal Waste Incineration	N/A
	Pathological Incineration	N/A
Lead	Battery Manufacturing	130
	Municipal Waste Incineration	2,600
	Sewage Sludge Incineration	27
	Waste Oil Combustion	540
Manganese	Battery Manufacturing	N/A
	Coal Combustion	2,200
	Distillate Oil Combustion	150
	Municipal Waste Incineration	260
	Reciprocating Diesel Engine	140
	Residual Oil Combustion	1
	Sewage Sludge Incineration	N/A
	Slash Burning*	780
	Turbine Diesel Engine	620
	Waste Oil Combustion	N/A
Mercury	Coal Combustion	11
	Sewage Sludge Incineration	2
Nickel	Coal Combustion	670
	Cooling Towers	0
	Distillate Oil Combustion	5,200
	Electroplating	<0.1
	Municipal Waste Incineration	570
	Portland Cement Manufacturing	0.1
	Reciprocating Diesel Engine	4,700
	Residual Oil Combustion	38
	Sewage Sludge Incieration	8
	Turbine Diesel Engine	22,000
	Waste Oil Combustion	N/A

TABLE 2-2. (Cont.)

SUMMARY OF AIR TOXICS EMISSION ESTIMATES

BY POLLUTANT FOR POINT AND AREA SOURCES IN ALASKA

Pollutant	Emission Source Type	Emissions (lb/yr)
PAH/POM	Airport Operations	N/A
	Asphalt Distribution & Usage	29
	Coal Combustion	12
	Distillate Oil Combustion	8
	Hot Mix Asphalt Production	38
	Mobile Sources	N/A
	Municipal Waste Incineration	5
	Reciprocating Diesel Engine	48
	Residential Wood Combustion	41,900
	Residual Oil Combustion	<0.1
	Sewage Sludge Incineration	11
	Slash Burning	15,000
	Turbine Diesel Engine	31
	Wood Combustion	30,000
	Waste Oil Combustion	22
Perchloroethylene	Dry Cleaning (Area Sources)	300,000
	Dry Cleaning (Point Sources)	52,000
PCB	Municipal Waste Incineration	<1
Phenol	Residential Wood Combustion	59,000
Radionuclides	Coal Combustion	1,400
	Distillate Oil Combustion	N/A
	Residual Oil Combustion	N/A
Toluene	Asphalt Distribution	35,000
	Mobile Sources	1,600,000
	Petroleum Marketing	33,000
	Paint Manufacturing	80
	Refinery Fugitives	20,000
Xylene	Airport Operations	120,000
	Asphalt Distribution	68,000
	Mobile Sources	390,000
	Petroleum Marketing	9,900
	Refinery Fugitives	30,000

TABLE 2-2. (Cont.)

Footnotes:

N/A - Emission estimates are not available at this time. A discussion of the information that is needed to estimate emissions is presented in Section Six.

(a) - Chromium emissions are calculated as total chromium.

* Benzene emissions are estimated for wood-burning stoves; emission factors for fireplaces were not available.

** The estimate is for the Fairbanks and Anchorage areas only.

TABLE 2-3.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK

Source Type	Ranking Factor	Number of Facilities	Comments
1. Municipal Solid Waste Incineration	1,100,000	8	Includes only those facilities burning more than 300 tpy.
2. Diesel Turbine Engines	250,000	14	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
3. Industrial Wood Combustion	150,000	5	Ranking does not take into account aldehyde emissions, which are unknown.
4. Distillate Oil Combustion	58,000	13	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
5. Reciprocating Diesel Engines	55,000	58	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
6. Coal Combustion	42,000	7	Ranking factor based on 1979 activity data.
7. Waste Oil Combustion	7,900	8	Ranking factor does not include three facilities. Activity data for these four facilities are unknown.
8. Gasoline Evaporation	2,700	23	Ranking factor based on 1979 activity data.

Continued

TABLE 2-3.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK (Continued)

Source Type	Ranking Factor	Number of Facilities	Comments
9. Pulp and Paper Mills	1,300	2	Ranking accounts for emissions from wastewater treatment.
10. Ethylene Oxide Sterilization	900	10	Ranking factor assumes all emissions are emitted at the hospital, which is not necessarily the case. A portion of the EtO is emitted from sewer lines.
11. Battery Manufacturing	900	1	Ranking does not take into account arsenic and chromium emissions.
12. Cooling Towers	600	2	Chloroform emissions from two other cooling towers are unknown. Ranking factor also does not include smaller cooling towers used for comfort cooling.
13. Municipal Sewage Incineration	500	1	Ranking based on Anchorage water and sewer facility only. Other incinerators in the state were found to have insignificant air toxics emissions.
14. Airports	480	6	Ranking based on six largest commercial airports. Emissions from military installations and non-commercial flights are not accounted for.

Continued

TABLE 2-3.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK (Continued)

Source Type	Ranking Factor	Number of Facilities	Comments
15. Hot Mix Asphalt Production	460	29	Ranking factor does not include six facilities from the south east portion of the state. The activity data for these facilities are unknown.
16. Residual Oil Combustion	430	1	Includes only facility emitting more than 2 tpy of PM or VOC.
17. Oil Refinery Fugitives	330	9	Ranking based on emission estimates calculated from production data obtained primarily from the Oil and Gas Journal.
18. Perchloroethylene Dry Cleaning	160	2	See also area source rankings.
19. Electroplating	40	2	Emission estimate for two of four facilities available.
20. Portland Cement Manufacturing	6	1	
21. Paint Manufacturing	<1	1	
22. Freon Dry Cleaning	0	1	Emissions are unknown. However, ranking factor expected to be a small value due to low toxicity of CFC-113.

Notes:

a) Sources are ranked according to their relative toxicity using threshold limit values.

b) Point source ranking factors are not directly comparable to area source ranking factors due to the diverse, widespread nature of area source emissions.

TABLE 2-4.

RANKING FACTORS FOR AREA SOURCE CATEGORIES

Area Source	Anchorage	Fairbanks	Juneau	Ketchikan Gateway	Sitka
Asphalt Distribution and Usage	380	120	43	24	18
Dry Cleaning	660	120	75	28	30
Mobile Sources	690,000	210,000	80,000	44,000	30,000
Petroleum Marketing	1,100	350	130	73	50
Residential Wood Combustion	8,600	200,000	120,000	68,000	41,000
Slash Burning	73,000[c]	1,900	NA	NA	NA

[d] Kenai Peninsula = 8,000 and Matanuska-Susitna Valley = 65,000

Notes:

a) Ranking factors are based on threshold limit values.

b) Area source ranking factors are not directly comparable to point source ranking factors due to the diverse, widespread nature of areas source emissions.

c) NA indicates not applicable.

In order to calculate the risk associated with these emissions, the dispersion potential of each source must be taken into account. This is done using air quality modeling to predict ground level concentrations. Air modeling and integrating the subsequent predicted ground level concentrations with the exposed population were not performed in this study.

SECTION 3

RECOMMENDATIONS FOR INVENTORY REFINEMENT

This section identifies and discusses those portions of the inventory that represent the highest priority for improvement in the future. These improvements are beyond the scope of this initial inventory. Specific recommendations for improving the Alaska inventory are discussed here, rather than more general recommendations such as improving emission factors for different types of sources.

Activity Data

For several of the point sources, activity data (i.e., production rates, material throughput, criteria pollutant emissions, etc.) were taken from the National Emissions Data System (NEDS). The last update for NEDS in the State of Alaska occurred in 1979. Consequently, these seven year old activity data may not accurately reflect the current air toxics emissions in the state.

Residential Wood Combustion

There is a large amount of information available from the wood use surveys conducted in Fairbanks and Juneau. Only a portion of this information was used to derive the emission estimates in this inventory. It is likely that a thorough review of the available information would allow a more precise specification of the types of combustion devices and fueling characteristics used, and would lead to the use of more accurate and specific emission factors.

Information on the relative fuel use rates of both fireplace and stove users in Fairbanks and Anchorage were not available from the survey summaries received from the ADEC. This information would lead to more accurate estimation of activity rates. In addition, the activity data used for Anchorage may not accurately reflect the residential wood combustion emissions for this area. The recent popularity of wood stoves and the growth in number of housing units in Anchorage since 1980 may result in an underestimation of the number of wood stoves and the amount of wood burned. An updated wood use survey for Anchorage may provide more accurate emission estimates.

Finally, survey information specific to Ketchikan and Sitka could be used in the development of more accurate emission estimates for those cities.

Airport Emissions

The activity data for airports, referred to as landing and take off cycles, are only directly available for the major carriers. Commuter and charter flights are not included in this inventory. Activity data for these smaller planes could be obtained by contacting each airport control tower. Including the emissions from these smaller planes would provide a more accurate estimation of emissions from the major airports.

Air toxics emissions from landing and takeoff cycles at the military bases are not included either. These sources could be surveyed to determine activity data and to determine representative plane types so that air toxics emissions could be estimated.

Slash Burning and Forest Fires

Additional research on the extent of slash burning and forest fires in Alaska would be very helpful. More importantly, information on the vegetation mass loading rates typical of various areas in the state would allow the use of much more precise emission factors and calculation of refined emission estimates.

Municipal Wastewater Treatment

Air toxics are emitted from publicly owned treatment works (POTW) that receive wastewater containing volatile hazardous constituents. Because the state of Alaska does not contain industry that typically uses solvents, we expect that air toxics emissions from Alaskan POTW are insignificant. There may be, however, significant emissions of chloroform from the chlorination of organic species in the treated wastewater. These assumptions could be verified by sampling raw and treated water samples to establish constituent concentrations. Mass transfer relationships could then be used to estimate emissions.

Asphalt Distribution and Usage

Emissions for this category were estimated using 1980 U.S. Department of Energy data. It appears that these data do not accurately reflect the quantity of asphalt currently consumed. If specific information regarding the quantities of asphalt cement, cutback asphalts and emulsified asphalts, are available from the Alaska Department of Transportation, they should be used in the inventory.

Mobile Source Emissions

Air toxics emissions for off-highway mobile sources have not been accounted for in this inventory. Criteria pollutant inventories compiled for other geographic areas have shown that off-highway mobile sources are a significant source of emissions.

SECTION 4

IDENTIFICATION OF AIR TOXICS EMISSION SOURCES

This section provides a description of the criteria that were used to determine whether air toxics sources were included in the emission inventory as point sources, area sources, or not included at all. This section also describes the information and references that were used to identify sources of air toxics.

FACILITIES IN THE POINT SOURCE EMISSION INVENTORY

Emissions of air toxics from facilities were either included in the point source inventory (with each facility specifically identified), or they were included in the area source inventory. The area source inventory does not identify facilities, but instead consists of aggregated emission totals. In order to determine which facilities should be included in the point source inventory, it was necessary to develop criteria for inclusion. Ideally, these criteria would be based on the magnitude of the health risk that each facility represents. If these types of criteria were to be developed, the following information would be required:

- the emission rate of each air toxic compound,
- the downwind concentrations that result from these emissions for each air toxic compound,
- the population that is exposed to these concentrations, and
- the relative toxicity of each air toxic compound.

For this inventory, it is not possible to take these factors into account quantitatively. However, these factors were kept in mind when developing the criteria for inclusion of facilities in the point source inventory. For example, there are numerous gasoline evaporation and reciprocating diesel engines located throughout the state of Alaska. To keep the number of facilities to a manageable size, only those sources with PM or VOC emissions of two tons per year or greater are included in the inventory. This cutoff allowed more effort to be focused on the highest priority sources. By focusing on a smaller number of sources, a more complete and accurate estimation of emissions from these sources can be obtained.

Table 4-1 presents the criteria that were used for selecting point sources. The reference materials that were used are discussed in greater detail in the following subsection. The source categories that were considered as area sources in this study are discussed in Section 6. Finally, a list of source categories that may emit small quantities of air toxics, but were judged not to be significant sources of air toxic compounds in this inventory, are presented in Table 4-2.

TABLE 4-1.

CRITERIA FOR INCLUSION OF FACILITIES ON THE LIST OF AIR TOXICS POINT SOURCES

INDUSTRY OR EMISSION SOURCE	CRITERIA FOR INCLUSION	SOURCES OF IDENTIFICATION
Airport Operations	Airports w/ major carrier service	Dept. of Transportation
Asphalt Cement	Stationary facilities	ADEC
Barrel Burning	All facilities	ADEC
Battery Manufacturing	All facilities	Telephone Book Yellow Pages
Chemical Manufacturing	All facilities with potential air toxics emissions	NEDS, SRI Directory of Chemical Producers, ADEC
Coal Combustion	PM or VOC emissions > 2 ton/yr	NEDS/CDS
Cooling Towers	Petroleum refineries, boilers greater than 100 MM Btu/yr	Survey/NEDS
Distillate Oil Combustion	PM or VOC emissions > 2 ton/yr	NEDS/ADEC
Dry Cleaning	Facility in NEDS/CDS	NEDS/CDS
Electroplating	All facilities	Telephone Book Yellow Pages
Ethylene Oxide Sterilizers	All facilities	Survey
Gasoline Evaporation	PM or VOC emissions > 2 ton/yr	NEDS/CDS
Incinerators	Major facilities	NEDS/CDS/ADEC
Internal Combustion-Diesel	PM or VOC emissions > 2 ton/yr	NEDS/CDS/ADEC

Continued

TABLE 4-1.

CRITERIA FOR INCLUSION OF FACILITIES ON THE LIST OF AIR TOXICS POINT SOURCES (cont.)

INDUSTRY OR EMISSION SOURCE	CRITERIA FOR INCLUSION	SOURCES OF IDENTIFICATION
Military Facilities	All facilities	Map of Major Army, Navy and Air Force installations in the U. S. (Defense Mapping Agency)
Paint Manufacturing	Include only facility	Telephone Book Yellow Pages
Portland Cement Manufacturing	Include only facility	CDS
Pulp and Paper Mills	All facilities	NEDS/CDS
Refinery Fugitives	All facilities	Assumed to be present at all oil refineries
Residual Oil Combustion	PM or VOC emissions > 2 ton/yr	NEDS/CDS/ADEC
Surface Coating	36 auto body paint shops picked at random	Telephone Book Yellow Pages
Waste Oil Combustion	All facilities	ADEC
Wood Combustion	PM or VOC emissions > 2 ton/yr	NEDS/CDS

INFORMATION USED TO IDENTIFY POINT SOURCES OF AIR TOXICS

The first step in performing this inventory was to develop a list of compounds to be considered as air toxics. Various lists of air toxics have been developed by several states and the EPA. Radian has reviewed these lists and developed a consensus list which incorporates 56 constituents as shown in Table 4-3. This list was used as the starting point for this project because it is based on a broad base of information and opinions as to what air toxics are important. A fairly large list of air toxics assures that a particular contaminant relevant to Alaska is included in the inventory.

Some of the references that were used to identify point sources of air toxics are listed in Table 4-1. However, the primary basis for identifying both point and area sources of air toxics was a cross-referenced list of air toxics and emission sources that Radian developed during a number of previous air toxics emission inventory studies. This cross-referenced list of air toxics and emission sources is presented in Appendix G for each of the 56 selected pollutants.

The list of air toxics and emission sources presented in Appendix G was used in conjunction with a number of other documents and information sources to identify facilities in Alaska that potentially emit air toxics. These sources are described below.

- NEDS - The National Emission Data System (NEDS) is an inventory of criteria pollutant emission sources. Generally, facilities are included in this inventory if they have emissions of 25 ton/yr or more of any criteria pollutant. For Alaska, however, NEDS identifies facilities with criteria emissions as low as one ton per year. NEDS provides a detailed breakdown of emissions by emission source for each facility that is included in the inventory. Information that can be used to estimate air toxics emissions such as activity data (e.g., throughput, fuel usage, production rate, etc.) are included in NEDS.

- The Alaska Petroleum and Industrial Directory - This document provides a list of a large percentage of the manufacturing and retail companies in Alaska. The directory is organized alphabetically by manufacturing or retail operation. Other than a fairly detailed listing of the products that a facility markets, there is little information that can be used to positively identify or quantify emissions of air toxics. Nonetheless, facilities potentially emitting air toxics were identified from this document.

TABLE 4-2.

POTENTIAL AIR TOXICS EMISSION SOURCE TYPES NOT INCLUDED ON THE LIST OF AIR TOXICS POINT SOURCES*

- Crude Oil Evaporation
- Distillate Oil Evaporation
- Jet Fuel Evaporation
- Kerosene Evaporation
- LPG Combustion
- Natural Gas Combustion
- Pathological Incineration
- Process Gas Combustion
- Concrete Batching
- Sand and Gravel Operations
- Stoddard Solvent Dry Cleaning
- Stone Quarrying

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* These sources were excluded because in general they have insignificant emissions of air toxics.

TABLE 4-3.

FIFTY-SIX SELECTED NON-CRITERIA POLLUTANTS

- Acetaldehyde
- Acrolein
- Acrylonitrile
- Allyl chloride
- Arsenic
- Asbestos
- Benzene
- Benzidine
- Beryllium
- Bis(chloromethyl)ether
- Cadmium
- Carbon tetrachloride
- CFC 113 (Freon 113)
- Chlorobenzene
- Chloroform
- Chloroprene
- Chromium
- Cresols
- Dibromoethane (Ethylene dibromide)
- 1,4-Dichloroethane
- 3,3-Dichlorobenzidine
- Dichloromethane (Methylene chloride)
- Dimethyl sulfate
- Dioxane
- Dioxins
- Epichlorohydrin
- Ethyleneimine (Aziridine)
- Ethylene oxide
- Formaldehyde
- Hexachlorocyclopentadiene
- Hydrazine
- Lead arsenate
- Maleic anhydride
- Manganese
- B-Naphthylamine
- Nickel
- Nitrobenzene
- N-Nitrosodimethylamine
- Nitrosomorpholine
- Parathion
- Phenol
- Phosgene
- Polychlorinated biphenyls (PCBs)
- Polycyclic Organic Matter (includes Benzo(a)pyrene)
- Propylene oxide
- Radionuclides
- Tetrachloroethylene (Perchloroethylene)
- Toluene
- 1,1,1-Trichloroethane (Methyl chloroform)
- Trichloroethylene
- Vinyl chloride
- Vinylidene chloride
- Xylene

- CDS - The Compliance Data System (CDS) is a computerized list of facilities currently under permit. The purpose of this data base is to track each facility's permit status. Typically there is enough information contained in this data base to determine whether or not the facility may emit air toxics. The information in CDS for the state of Alaska is generally more up-to-date than NEDS and was used to supplement information from NEDS.

- The SRI Directory of Chemical Producers - This document provides a list of the chemical manufacturing companies and facilities in the United States. The document is organized in several ways including chemical compound (or class of compounds), county, and city. This document is very useful in identifying chemical manufacturing facilities. However, no information such as production capacity is provided that could be used to quantify emissions of air toxics.

- Telephone Book Yellow Pages - There are some facilities that potentially emit air toxics that are not significant emitters of criteria pollutants and not included in NEDS. For these types of facilities, such as chrome plating shops, the Yellow Pages is a valuable source of information.

From the draft inventory, the ADEC was able to identify additional relevant facilities that were not identifiable from these data sources. At the same time, the ADEC also flagged erroneous facilities that were obtained from NEDS. These facilities were removed from the data base.

INFORMATION USED TO IDENTIFY AREA SOURCES OF AIR TOXICS

The information sources that were used to identify area sources of air toxics in Alaska are described below:

- the list of air toxics and emission sources presented in Appendix G,

- lists of area sources of air toxics that have been included in other air toxics emission inventories (e.g., the Washington Toxics Air Contaminant Study (Radian, 1985)), and

- the reports to the Scientific Review Panel on air toxics published by the California Air Resources Board staff.

From this information, the following area sources of air toxics for the state of Alaska were identified:

- ashpalt distribution and usage,
- dry cleaning,
- mobile sources,
- pesticide application,
- petroleum marketing,
- residential wood combustion, and
- slash burning and forest fires.

Emissions from these sources are estimated for Anchorage, Fairbanks, Juneau, Ketchikan Gateway and Sitka. These five areas comprise almost 67 percent of the Alaskan population.

SECTION 5

SURVEY OF SOURCES

A summary of the survey activities and results are discussed in this section.

PRIORITIZATION OF SOURCES FOR SURVEY

One of the first tasks in this project was to develop a list of facilities to be included in the point source emission inventory. Once the list of point sources was developed, each emission source type on the list was evaluated in terms of the usefulness of obtaining additional information through facility surveys. Based on this evaluation, an initial prioritized list of sources for survey was developed. This prioritization took into account the following considerations:

- The need for survey data. The only emission sources that were included on the prioritized list were sources where survey data were required in order to estimate air toxics emissions.
- The results of obtaining survey data. If obtaining survey data would allow the estimation of air toxics emissions, the source was prioritized higher than sources for which additional information beyond survey data would be required.
- The expected relative importance of the emission sources. Sources that were expected to have high emissions for the more toxic compounds were prioritized highest.
- The number of facilities to be surveyed. Source types with fewer facilities were prioritized higher so that multiple source types could be surveyed.

These considerations represented a large number of competing factors to take into account in prioritizing sources for survey. Thus, relatively subjective judgements were made as to the importance of survey activities for various emission source types. The resulting initial prioritized list of source types is presented in Table 5-1.

The prioritized list of sources for survey was reviewed by individuals from EPA and the ADEC (Alaska Department of Environmental Conservation). Based on the comments received, a final decision was made on the number and types of sources to be surveyed. Table 5-1 shows that 33 autobody paint shops and 12 cooling towers were added to the survey effort.

The survey effort for cooling towers was limited to petroleum refineries and boilers greater than 100 million Btu per hour. These criteria reduced the number of facilities requiring surveying to 12.

TABLE 5-1.

PRIORITIZED LIST OF EMISSION SOURCES FOR SURVEY

Emission Source Category	Number of Facilities Requiring Surveying
Initial Prioritized List	
Industrial Incineration	45
Sewage Sludge Incineration	4
Military Facilities	7
Electroplating	4
Ethylene Oxide Sterilization	32
Paint Manufacturing	1
Battery Manufacturing	2
Source Categories Added	
Cooling Towers	12
Autobody Paint Shops	33
TOTAL	143

Throughout the state of Alaska, there are over a hundred facilities that may be involved in painting cars. In order to keep the survey effort to a manageable size, 33 of these facilities were sent questionnaires. Twenty-two of these facilities were in Anchorage, six were in Fairbanks, and five were in Juneau.

Survey Approach

Nine different questionnaires, and a cover letter were developed for the following source categories:

- industrial incineration,
- sewage sludge incineration,
- electroplating,
- ethylene oxide sterilization,
- paint manufacturing,
- battery manufacturing,
- cooling towers,
- surface coating, and
- degreasing.

These questionnaires and the questionnaire cover letter are presented in Appendix F.

Prior to mailing the surveys, facilities not under permit in Alaska were telephoned to inform personnel about the survey and to identify an individual to which to address the survey. For the remaining facilities, facility addresses and plant contacts were obtained from the ADEC. The cover letter for the survey requested that the survey be returned approximately one month after the receipt of the survey. Follow-up calls were made to those facilities that had not returned the surveys. In a few cases follow-up calls were made to clarify information provided in the returned questionnaires.

SUMMARY OF SURVEY RESULTS

The percentage of questionnaires returned is presented in Table 5-2 by source category. The number of surveys that were returned are summarized below.

Autobody Paint Shops

Questionnaires were sent to 33 autobody paint shops. Originally, two questionnaires were returned, only one of which was completed. In our follow-up telephone calls to these facilities, we were informed by nine facilities that they never received the questionnaire. However, prior to sending out the questionnaires, each autobody paint shop was contacted to establish a facility contact and to confirm a mailing address.

It appears that many of these facilities discarded the questionnaire for fear of possible regulatory repercussions. A second questionnaire was sent to the 31 facilities who did not respond. A new cover letter was included urging

TABLE 5-2.
PERCENTAGE OF SURVEYS RETURNED

Emission Source	Number of Facilities Surveyed	Number of Surveys Returned	Percentage of Surveys Returned
Industrial Incineration	46	3	7
Sewage Sludge Incineration	2	2	100
Military Facilities	7	4	57
Electroplating	3	2	67
Ethylene Oxide Sterilization	32	26	81
Paint Manufacturing	1	1	100
Battery Manufacturing	2	2	100
Cooling Towers	13	6	46
Autobody Paint Shops	33	10	30

them to participate in this study. An additional eight facilities responded to the second mailing.

Battery Manufacturing

Questionnaires were sent to two facilities. Both facilities returned the questionnaire, but only one of these facilities actually manufactures batteries.

Cooling Towers

Thirteen cooling tower questionnaires were sent out; responses from six facilities have been received. At the outset of the survey activities, it was anticipated that the petroleum refineries in Alaska would operate cooling towers. It turns out that none of the five petroleum refineries actually have a cooling tower.

Electroplating

From the telephone book yellow pages, three electroplaters were identified in Alaska. Two of these facilities returned the questionnaire.

Ethylene Oxide Sterilization

Based on information obtained form the Alaska Department of Health and Social Services, there are 20 community or private hospitals, 6 U.S. public health services, and 6 military hospitals operated in the state. Only 10 of the 26 facilities returning questionnaires have ethylene oxide sterilizers.

Industrial Incineration

The initial review of NEDS identified 46 industrial incineration facilities located throughout the state. A questionnaire was developed and delivered to each facility in order to identify the types of wastes being incinerated. This questionnaire would have provided the necessary information to calculate inorganic air toxics emissions. As it turned out, only one of the facilities identified through NEDS really incinerated industrial waste. The remainder of the incinerators were either no longer in service or municipal waste or sewage sludge were being burned. Data and information obtained on these two source categories have been incorporated into the inventory. Although a completed industrial incineration questionnaire was not received, all incinerators listed in NEDS were accounted for.

Military Facilities

There are seven military installations listed by the defense mapping system for the state of Alaska. The possible source categories each facility may have are electroplating, surface coating, and degreasing. These questionnaires were delivered to Clam Lagoon, the Army (Fort Richardson), and the Air

Force (Elemendorf). Four sets of completed questionnaires were returned. From the completed questionnaires, no significant sources of air toxics were identified.

Paint Manufacturing

There is one paint manufacturing facility in Alaska. This facility has returned a completed questionnaire.

Sewage Sludge Incineration

Initially, four facilities were identified for this source category. However, it was subsequently learned that only two of the four incinerators are currently operating. Completed questionnaires for both facilities were received.

An additional facility was identified through the industrial incineration surveys that were sent out. Sufficient information was obtained from this facility to estimate toxic organic emissions.

SECTION 6

ESTIMATION OF AIR TOXICS EMISSIONS

This section presents a discussion of the point and area source emission estimates. A brief description of each source is provided along with a detailed explanation of the methodology used to calculate emissions.

POINT SOURCE EMISSION ESTIMATES

As described in Section 4, a list of point sources to be included in the point source emission inventory was developed. The literature was reviewed for each emission source type in the inventory to determine the most accurate and technically sound emission estimation method. The majority of emission estimation methods consisted of using emission factors in conjunction with one of the following types of information.

- Volatile organic compounds (VOC) and/or particulate matter (PM) emissions. With the exception of oil refinery fugitives, these data were obtained from the 1979 version of NEDS, which was the most recent version available when Radian began this inventory. Oil refinery fugitive emissions were calculated by Radian.

- Activity data (i.e., fuel consumption, production rate, etc.). In general, these data were also obtained from the 1979 version of NEDS. Activity data for municipal solid waste incineration, hot mix asphalt plants, and certain diesel generators were obtained from the ADEC.

- Survey results. In almost all cases, these data were for the 1985 calendar year.

Where different emission factors were available for a particular emission source type, selection of an emission factor was based on the following priorities:

- emission factors that are widely accepted and have been used in other studies were given high priority; and

- emission factors that have not achieved wide acceptance but were judged to be technically sound were also given high priority.

The documentation for the emission factors is presented in Appendix B. Preference was given to the development of uncontrolled emission factors so that facility specific control efficiencies could be applied. Once emission factors and activity data were obtained, they were entered into a computerized emission inventory and air toxics emissions were calculated.

For several of the source categories, emission estimates were calculated using material balances from data and information obtained from survey questionnaires. In other instances, source test data were available. In these two instances, the emission estimates were entered directly into the computerized data base of emission estimates. Corresponding activity data and emission factors are reported as not available.

Many of the emission sources located in the state of Alaska are potential emitters of polycyclic organic matter (POM). Polycyclic organic matter generally defines organic species with structures having two or more fused aromatic rings (i.e., rings which share a common border). Wherever possible, emissions were estimated for polynuclear aromatic hydrocarbons (PAH) rather than POM. The family of PAH consists of the following 14 compounds or classes of compounds: naphthalene, phenanthrene, anthracene, fluoranthene, acenaphthalene, chrysene, benzo (a) anthracene, cyclopenta (c, d) pyrene, the benzpyrenes, indeno (1,2,3-c,d) pyrene, benzo (g,h,i) perylene, coronene, and some of the alkyl derivatives of these compounds.

Particulate matter control devices have varying degrees of success in controlling PAH emissions. PAH contained in the flue gas entering the control device will be present in both the solid and gas phase. Consequently, the control device is only partially effective in removing PAH. Table 6-1 illustrates how flue gas temperature affects PAH removal. Because it was not possible to take into account the flue gas temperature at each facility in compiling the inventory, we assumed that particulate matter control devices did not remove any PAH. This assumption will provide a slight overestimation of PAH emissions.

Results from the emission inventory are presented in several formats with varying levels of detail. In Tables 2-1 and 2-2 within Section 2, emissions are summarized for the entire state of Alaska. In Appendix A, point source emissions are grouped by Standard Industrial Classification (SIC) Code and source category.

A brief discussion of each point source and the specific methodology used to calculate emissions are presented below.

Airport Operations

Emissions from airports result primarily from combustion of jet fuel during landing and takeoff operations. The landing/takeoff cycle includes the idling, takeoff, climb, and approach phases. The contaminants of concern include benzene, xylene, formaldehyde, PAHs, and dioxins. Airport activity data were obtained from the annual Federal Aviation Administration (FAA) compilation of airport activity of certified route carriers for 1984. This method excludes charter and private plane activity. Activity data were not available for these smaller planes.

The activity data reported in the inventory are tons per year of total hydrocarbon emissions. Total hydrocarbon emissions were calculated by

TABLE 6-1.

PERCENT OF TOTAL PAH ASSOCIATED WITH SOOT PARTICLES AS A FUNCTION OF FLUE GAS TEMPERATURE

Compound	40°C	55°C	85°C	200°C
Naphthalene	56	6.5	4.3	0.11
Methylnaphthalene	39	a	20	0.00
Biphenyl	89	77	48	0.46
Biphenylene	88	70	66	0.09
Fluorene	98	94	b	2.1
Phenanthrene and Anthracene	90	92	71	4.6
4H-cyclopenta- (d,e,f)phenanthrene	97	b	85	2.3
Fluoranthene	99	b	82	38
Pyrene and Benzacenaphthylene	99	b	83	33

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[a] GC/MS analysis not available.

[b] Too much background from contaminants to determine accurate values.

Source: G. Prado, Formation of Polycyclic Aromatic Hydrocarbons in Premixed Flames, Chemical Analysis and Mutagenicity. in: Polynuclear Aromatic Hydrocarbons Chemical Analysis and Biological Fate, Proceedings of the Fifth International Symposium on Polynuclear Aromatic Hydrocarbons, Battelle Press, Columbus, OH, 1981.

summing the number of landing/takeoff cycles for each plane type, multiplying by the total emissions per cycle for each plane type (ARB, 1982a), and then summing the emission totals to obtain an annual hydrocarbon emission estimate for each airport. Table 6-2 contains the calculated activity data.

A VOC species profile (CARB, 1982b) for jet exhaust was used to speciate the hydrocarbon emissions. Information was available for benzene, xylene, and formaldehyde. The formaldehyde emission factor was not used because it was developed for a specific plane type and cannot be generalized for the full range of plane types or total emissions. No emission factors were found for PAHs and dioxins in the literature that was surveyed.

Asphalt Cement (Hot Mix) Plants

Asphalt binders are heated and mixed with aggregate for use as paving material. During this heating and mixing, emissions of benzene, PAH, and formaldehyde may result.

Asphalt cement plants have been identified as sources of benzene, formaldehyde, and PAH emissions. These plants operate in either a batch or continuous mode. Emission factors are the same for both operation types.

Activity data were obtained from the Alaska DEC as reported to the DEC by the asphalt plant operators. The data supplied were tons of asphalt produced annually. Emission factors are based on tonnage produced, and are therefore directly applicable for the estimation of emissions.

Barrel Burning

At Prudhoe Bay, ARCO Alaska, Inc. operates a barrel burning process in which crushed drums are incinerated in an open pit drum incinerator using a gas flare. The purpose of the incinerator is to destroy residual liquids contained in the empty crushed drums prior to shipment to the North Slope Borough landfill. Listed hazardous wastes, except those adhering to the drum walls, are not permitted in the incinerator.

A review of the operating permit for this operation indicates that the liquid wastes entering the incinerator are primarily oils and greases. All liquids are drained from the drums prior to crushing. The possible air toxics from this operation include metals, formaldehyde, PAH, and dioxins/furans. However, there is little information available in the literature on the combustion products of an incineration operation of this type. Emissions from this operation must be source tested in order to determine the air toxics emissions.

Battery Manufacturing

The manufacture of storage batteries involves the production of lead plates which are then placed and aligned in a plastic case. During battery manufacture, particulate matter is emitted from such production operations as

TABLE 6-2.

TOTAL HYDROCARBON EMISSIONS BY AIRPORT AND PLANE TYPE

(Units are lbs/yr)

Plane Type	Anchorage	Fairbanks	Juneau	Dead Horse	Ketchikan	Sitka
B 707	14,840					
B 727	156,992	57,133	34,850	4,717	24,407	15,967
B 737	89,152	37,112	8,826	21,611	5,134	3,136
B 747	148,523	905				
B 767	3,280	108				
DC 8	104,494	15,757				
DC10	56,237	141				
L 100	20,288	6,697				
DC 6	20,660					
HS 125	1,526					
C 441	721					
F 27	11,838					
L 188	5,578					
TOTAL	634,129	117,853	43,676	30,767	29,541	19,103

lead paste mixing, lead oxide production, and lead reclaim furnaces. Air toxics from battery manufacturing include lead, arsenic, and cadmium. There is one battery manufacturing facility in the state of Alaska.

This facility, Alaska Husky Battery, purchases lead oxide as a raw material rather than formulating it on site. The production operations at this facility that generate particulate are lead paste mixing, grid casting, and battery assembly. Emission factors for lead were obtained from AP-42. Emission factors or particulate speciation data for arsenic and cadmium were not available. The emission factors from AP-42 were combined with production data supplied in a questionnaire to estimate emissions.

Chemical Manufacturing

A review of the SRI Directory of Chemical Manufacturers indicates there are three chemical plants in Alaska. Of these, the Unocal Chemical facility is the only one of importance in terms of air toxics. This facility manufactures urea and ammonia. Urea is manufactured by reacting ammonia and liquid carbon dioxide at elevated temperatures and pressures to form ammonium carbonate. This chemical decomposes at lower pressures to urea and water. It was initially thought that this facility may emit formaldehyde. However, formaldehyde emissions are associated with urea-formaldehyde resin manufacture and are not expected to be present at the Unocal Chemical facility.

In addition to ammonia emissions, the ADEC reports that the Unocal Chemical facility also emits arsenic as a result of the burning of a waste-product that contains arsenic. Source testing data from this facility are shown in Appendix A under SIC code 2873.

The other two chemical plants located in the state of Alaska are Liquid Air Corporation and Big Three Lincoln Alaska. Both facilities manufacture acetylene and operate air separation plants for the production of oxygen and nitrogen. There are no known air toxics emissions associated with these chemical manufacturing operations.

Combustion Sources

In the state of Alaska, there are numerous potential sources of air toxics emissions from the combustion of several different fuels. In order to keep the number of facilities to a manageable size, only those combustion sources with particulate matter (PM) or volatile organic compound (VOC) emissions equal to or greater than two tons per year are included in the inventory. Waste oil combustion sources are an exception to this cut-off, where all known sources have been included.

Through a review of NEDS and discussions with the ADEC, we have identified the following combustion sources:

- eight facilities burning coal,
- one facility burning residual oil,
- seventeen facilities burning distillate oil,
- four facilities burning waste oil,
- thirty seven facilities operating reciprocating diesel engines,
- one facility operating a diesel turbine, and
- six facilities burning wood.

These fuels are used throughout the state to generate electricity, produce process steam, or for the operation of petroleum pipelines. Air toxics that may be emitted from the combustion of these fuels include a wide variety of both metals and toxic organics.

With the exception of one facility burning waste oil, air toxics emissions from these combustion sources were estimated using emission factors. Activity data were obtained from NEDS and ADEC. Waste oil burned at the Unocal chemical facility is known to contain more arsenic than is typically found in waste oil. The arsenic emissions from this facility were adjusted to account for the higher arsenic levels. Other air toxics emissions from this source were estimated using the emission factors for a nonindustrial boiler as described in Appendix B.

Emissions from the Mitkoff Lumber silo burner were estimated using the emission factors developed for wood-fired boilers due to the lack of any other data. These emission factors may understate the emissions from this silo burner because the combustion efficiency of the silo burner is expected to be lower than that of a boiler. Increased combustion efficiency should provide lower hydrocarbon emissions, and thus, lower air toxics emissions.

Cooling Towers

The potential air toxics from a cooling tower are chromium, nickel, and chloroform. Chromium and nickel compounds can be used as scale and corrosion inhibitors in a cooling tower. Source testing has shown that these elements are emitted to the atmosphere as part of the cooling tower drift. Chemical additives comprised of nickel and chromium are in limited use today as a result of the development and use of organophosphates. This appears to be the case for the cooling towers surveyed in Alaska.

In addition to scale and corrosion inhibitors, various chemicals are added to cooling towers to control biological growth. The most prevalent biocide is chlorine, which ultimately results in chloroform emissions.

Cooling tower questionnaires were sent to the following facilities:

- all six of the petroleum refineries,
- all facilities listed in NEDS as operating boilers greater than 100 million Btu per hour,

- the Unocal Chemical Division chemical facility, and
- the Phillips Petroleum natural gas liquifying facility.

Each facility was requested to submit information detailing the types and quantities of chemicals used in their cooling circuits. In addition, the questionnaire requested information on the volume of cooling water used. From this information, it is possible to estimate emissions using emission factors presented in the EPA "Locating and Estimating" document for chloroform (U.S. EPA, 1984e). These emission factors, however, overstate the quantity of chloroform that could be emitted by each facility. That is, the emission factors predicted chloroform emissions that exceeded the quantity of chlorine used in the system. Consequently, the information and data presented in the questionnaires were used to calculate emissions. A material balance was performed around each system by calculating the amount of chlorine removed through the system as blowdown and cooling tower drift. The chlorine content of the drift was assumed to be the same as the blowdown. The difference between the chlorine used in the system and that leaving through blowdown and drift was assumed to be converted to chloroform.

Dry Cleaning

Dry cleaning operations use one of three solvents: tetrachloroethylene (also referred to as perchloroethylene, or PCE), CFC 113 (freon), or stoddard solvents. Stoddard solvents consist primarily of paraffins and no air toxics have been identified in stoddard solvents. Tetrachloroethylene and CFC 113 are considered air toxics.

Four dry cleaning operations have been identified in Alaska which use one of these solvents. The point source inventory includes only large operations and not smaller shops and cleaners. These smaller operations are accounted for in area emission estimates.

Emission estimates were obtained from the NEDS for two of the plants, both of which use PCE. No data were available for the other two plants, both of which use CFC 113. The plants using CFC 113 are both associated with federal installations, for which data appear to be limited.

Electroplating

Electroplating is a process in which metal in solution is electrically deposited (plated) onto a metal object. Plating solutions typically contain nickel, chromium, cadmium, or zinc. Chromium and nickel are the most prevalent air toxics emitted during electroplating. Through a search of the telephone book yellow pages, we have identified four electroplaters in Alaska.

The size of plating baths and the total current used at each electroplating facility were solicited through surveys. Only two of the surveys were returned. Emission factors for chromium and nickel were developed from data presented by several investigators and are described in Appendix B.

Ethylene Oxide Sterilizers

Many hospitals throughout the U.S. utilize ethylene oxide (EtO) to sterilize reusable medical equipment. Ethylene oxide is used when the heat or humidity necessary for steam sterilization would degrade the material to be sterilized. Emissions from the sterilization procedure may be composed of pure EtO or a mixture of EtO with other gases, such as freon or carbon dioxide. These emissions are vented to the atmosphere through a water-sealed pump, which also produces an EtO laden liquid steam. Because most or all of the EtO in this liquid stream eventually revolatilizes, we have assumed that all of the EtO used in sterilizers is emitted to the atmosphere.

Information on ethylene oxide use at Alaskan hospitals was acquired through a survey of all state hospitals. The results of this survey indicate that most Alaska hospitals do not use EtO for sterilization. However, 10 hospitals which do use ethylene oxide were identified.

Gasoline Evaporation

In the state of Alaska, there are numerous facilities with VOC emissions from gasoline evaporation that are large enough to be included in NEDS. Facilities that are included in NEDS and have VOC emissions from gasoline evaporation greater than two tons per year are considered point sources in the inventory. We have identified 24 facilities that meet these criteria.

The most important air toxics associated with gasoline evaporation are benzene, ethylene dibromide, and ethylene dichloride. These latter two compounds are associated with leaded gasoline only.

Air toxics emissions from gasoline evaporation were estimated using the VOC emission estimates contained in NEDS for each facility. The VOC emissions were speciated to provide an air toxics emission rate.

The VOC speciation data that were used to estimate emissions of EDB and EDC were obtained from data and literature published in 1984. At that time, the allowable lead content of gasoline was 1.1 grams per gallon. In January of 1986, the allowable lead concentration was reduced by EPA to 0.1 grams per gallon. This reduction in lead content will result in a proportional decrease of EDC and EDB emissions. These organic compounds are added to gasoline to scavenge and remove lead from the engine. Consequently, reducing the lead content of gasoline has reduced the EDB and EDC emissions. The emission factors used in this inventory reflect the gasoline lead limitations promulgated in January of 1986. Finally, it should be noted that EPA has proposed a complete phase out of leaded gasoline by 1988. If this rule is promulgated as proposed, emissions of EDB and EDC from gasoline evaporation would be eliminated.

Industrial Incineration

From NEDS and CDS, 46 industrial incinerators burning nonhazardous waste were initially identified. According to the ADEC, there are no hazardous waste incinerators in the state.

Questionnaires were used to gather information on each incinerator identified in NEDS. We were able to determine the disposition of each industrial incinerator listed in NEDS. Of the 46 listed, only one facility was found to be burning an industrial waste. This facility, the Alyeska Pipeline Service Company in Valdez, reported burning an oily waste. Insufficient information was presented to calculate emissions. The other incinerators listed in NEDS either no longer exist, or they are actually sewage sludge or municipal solid waste incinerators. Questionnaire information obtained from these other incinerator types are included in the inventory as appropriate.

Municipal Solid Waste Incineration

There are numerous incinerators used throughout the state to reduce the quantity of municipal waste requiring land disposal. The largest facilities have been included in the inventory. Source tests of municipal waste incinerators have shown the presence of PAH, furans, dioxins, PCBs, and various toxic inorganics.

-Emission factors for this source were developed for single chamber, multiple chamber, and controlled air incinerators in order to estimate emissions. Activity data, or the amount of waste burned, for each incinerator were obtained from the ADEC.

After reviewing the draft emission estimates, the ADEC calculated and supplied to Radian facility-specific particulate matter control factors. The control factors take into account the particulate matter emission rate used in developing the emission factors and the actual measured particulate emissions from each incinerator. In essence, developing control factors in this manner speciates the actual particulate emissions of each facility, yielding more accurate emission estimates.

A control factor of 0.65 was used for the North Slope Borough incinerator to account for the differences in actual particulate emissions and those used to develop the emission factor. Particulate emissions for this incinrator are currently uncontrolled, but an electrostatic precipitator will be installed for particulate control in 1988.

Paint Manufacturing

From the telephone book yellow pages, one paint manufacturing operation was identified in Alaska. From a completed questionnaire, it was determined that this facility emits 80 pounds of toluene.

Portland Cement Manufacturing

Alaska Basic Industries of Anchorage is the only Portland cement manufacturing operation in the state of Alaska. This particular facility, however, does not operate a kiln. Clinker, produced in a cement kiln, is transported to Anchorage via boat from Japan and Seattle. Once received in Anchorage, the clinker is ground to produce cement. Two ball mills are located on site with a baghouse to control particulate emissions. Air toxics of concern from this facility are nickel and chromium.

Emission factors for a wet process cement grinder were used to estimate emissions for this facility. Dry process emission factors were not used because they include emissions from the grinding of raw materials that are fed to the kiln, a process which does not occur at Alaska Basic Industries. In the wet process, as the name suggests, raw materials are ground in the presence of water, eliminating particulate emissions. Wet process grinding emission factors account for the emissions that occur from the grinding of clinker, which is the process conducted by Alaska Basic Industries.

The activity data, the amount of clinker ground, was obtained from the ADEC. With this information, and assuming the baghouse is 99.8 percent efficient in controlling particulate matter, it was estimated that 0.14 pounds of nickel and .024 pounds of chromium are emitted each year.

These emission estimates do not include nickel and chromium emissions that result from truck and rail loading operations and the main load out silo. According to CDS, these three operations emit 32 pounds per year of particulate. Unfortunately, the chromium and nickel content of this particulate is unknown.

Pulp and Paper Mills

Based on information from ADEC, two pulp and paper mills in the state of Alaska use chlorine bleach. These mills, both of which produce dissolving sulfite pulp, are located in Ketchikan and Sitka. As a result of the use of chlorine bleach, chloroform emissions are produced, primarily during wastewater treatment.

Emissions were estimated using activity data obtained from the ADEC and reported emission factors.

Refinery Fugitives

Petroleum refinery fugitive emission sources include valves, flanges, pumps, compressor seals, process drains, and cooling towers. They are not associated with a specific process, but occur throughout the refinery. The emissions of concern are volatile organic compounds, including benzene, toluene, and xylene.

TABLE 6-3.

VOC EMISSION ESTIMATES FOR ALASKAN PETROLEUM REFINERIES

Refinery	Process Unit Fugitive Emissions (lb/day)	Total Fugitive (lb/day)	Refinery Emissions (ton/yr)
ARCO - Kuparuk			
Crude Distillation	880		
Refinery Total		880	160
ARCO - Prudhoe Bay			
Crude Distillation	880		
Refinery Total		880	160
Chevron U.S.A. - Kenai			
Crude Distillation	880		
Asphalt Production	81		
Refinery Total		960	180
MAPCO Petroleum Inc. - North Pole			
Crude Distillation	91		
Aromatics Extraction	1,200		
Asphalt Production	80		
Refinery Total		2,200	400
Petro Star Inc. - North Pole			
Crude Distillation	880		
Refinery Total		880	160
Tesero Petroleum Corp. - North Pole			
Crude Distillation	900		
Catalytic Reforming	940		
Catalytic Hydrocracking	770		
*Catalytic Hydrotreating	860		
Hydrogen Production	650		
Refinery Total		4,100	750
Arctic Energy - Fox			
Crude Distillation	880		
Vacuum Distillation	360		
Lubes Processing	590		
Asphalt Production	80		
Refinery Total		1,900	350

Continued

TABLE 6-3.

VOC EMISSION ESTIMATES FOR ALASKAN PETROLEUM REFINERIES (Continued)

Refinery	Process Unit Fugitive Emissions (lb/day)	Total Fugitive (lb/day)	Refinery Emissions (ton/yr)
Alyeska Pump Station #6			
Crude Distillation	870		
Vacuum Distillation	360		
Lubes Processing	590		
Asphalt Production	80		
Refinery Total		1,900	350
Alyeska Pump Station #8			
Crude Distillation	880		
Vacuum Distillation	360		
Lubes Processing	590		
Asphalt Production	80		
Refinery Total		1,900	350
Alyeska Pump Station #10			
Crude Distillation	880		
Vacuum Distillation	360		
Lubes Processing	590		
Asphalt Production	80		
Refinery Total		1,900	350

The best method for estimating refinery fugitive air toxics emissions is to speciate hydrocarbon emissions. Fugitive hydrocarbon emissions for the Alaska refineries were not available; therefore, these emissions were calculated as a part of this inventory.

Table 6-3 presents the estimates of fugitive emissions from each process unit in each refinery as well as refinery totals. The estimates were made based on models obtained from "A Model for Evaluation of Refinery and Synfuels Hydrocarbon VOC Emission Data" (Radian, 1983). With the exception of the Alyeska and Arctic Energy facilities, production information was obtained from the Oil and Gas Journal (1986 Annual Refining Survey). Production data for the two Alyeska and Arctic Energy facilities were obtained from the ADEC.

Four major assumptions were necessary to calculate fugitive hydrocarbon emission estimates. They are as follows:

- It is assumed that gas oil hydrotreating is performed at the Tesoro Petroleum Corporation refinery in North Pole rather than middle distillate or naphtha hydrotreating.

- Since no specific information is available on production for the topping plants at the Arctic Energy refinery or the Alyeska pump stations, it is assumed that the refineries are "typical" topping classification refineries as described in the 1985 California Oil Scenario Study (Bonner & Moore Associates, Inc., 1985).

- Combustion emissions are calculated for each unit based on 100% capacity. If a process unit is run at a level below 100%, the combustion emissions estimate can be scaled linearly. A review of the results for combustion emissions with respect to fugitive emissions will illustrate the minor impact combustion emissions have relative to fugitives (<4% in all cases). Therefore, errors due to lack of knowledge of combustion processes will be minimal.

- It is assumed that fugitive emissions from ancillary units (product storage, utilities, wastewater treatment and blowdown/flare) are included in the estimates for the primary process units.

All of the Alaska refineries were defined as topping refineries except the Tesoro Petroleum Corporation refinery in Kenai, which has cracking and reforming capabilities. The topping refineries have lower emission factors than the more complex refineries. Air toxics emissions were calculated by using speciation data (emission factors) that were applied to the VOC emission estimates (activity data). Appendix B presents the development of the emission factors.

Sewage Sludge Incineration

Sewage sludge incinerators typically destroy biological treatment sludge and wastewater "scum." There are three sewage sludge incinerators in the state.

Organic air toxics from these incinerators are expected, but the extent to which inorganics are emitted is highly dependent upon the amount of industrial wastewater received at the facility. In order to estimate inorganic emissions from these facilities, questionnaires were used to obtain information on the mass of sludge incinerated and the associated inorganics content. Data and information contained in one of the completed questionnaires was used to perform a material balance around the incinerator to estimate emissions. The other two facilities did not have any metal concentration data for either the raw sludge or incinerator ash. However, these two facilities, Standard Alaska Production Company on the North Slope and the Wrangell Wastewater Treatment Plant, do not receive industrial wastewaters. Consequently, the metals emissions from these two facilities are expected to be minimal.

Emission factors were used to estimate PAH and dibenzofuran emissions. These emissions for the two incinerators listed above were found to be less than a pound per year. Emissions of less than a pound per year are considered insignificant. These two facilities, therefore, are not included in the computerized emission inventory. Emission estimates from the Anchorage incinerator are presented under SIC code 4952 in Appendix A.

Surface Coating

This operation involves the application of paint, varnish, lacquer, or paint thinner for decorative or protective purposes. The paint "vehicle" consists of organic solvents that facilitate application. A large percentage of the paint is volatile and evaporates upon application. With the exception of autobody paint shops, no large scale surface coating operations were identified in Alaska. There are 58 autobody paint shops in Anchorage, 12 in Fairbanks and six in Juneau. Questionnaires were sent to 33 of these shops and nine were returned. Of these nine questionnaires, two responses were not used due to the inordinate amount of paint consumed as compared to the other facilities. The seven remaining sets of data were then averaged to obtain a "typical" facility consumption rate. This rate was then used to calculate total VOC emissions rates for Anchorage, Fairbanks and Juneau.

The typical (or average) autobody paint shop in Alaska applies approximately 250 gallons of surface coating material per year. Using an auto body painting emission factor of 5.275 pounds of solvent per gallon of coating material (ARB, 1982), the solvent emissions from a typical shop are estimated to be 1,300 pounds per year. Emissions were then calculated as 37.7 tons of solvent per year in Anchorage, 7.8 tons per year in Fairbanks, and 3.9 tons per year in Juneau.

VOC speciation data could be used to estimate emissions on a facility-by-facility basis. However, the solvent composition of paint is highly variable, even within the broad classifications typically used. Speciation data, as reported by Oliver et al. (1985), are shown in Appendix D for various surface coating materials.

AREA SOURCE EMISSION ESTIMATES

Estimates of potential emissions from each of the area sources identified in Section 4 were developed. This section contains a condensed description of the information sources and methodology used to develop those estimates. The emission estimates are summarized in Section 2; a complete description of the emission estimation process is contained in Appendix C.

Asphalt Distribution and Usage

The use of asphalt may result in the emissions of the following air toxics: formaldehyde, polycyclic organic matter, benzene, toluene, and xylene. There are three different asphalt types, each of which has different emission characteristics. The different types are asphalt cement, cutback asphalts, and emulsified asphalts.

Activity data were compiled from two sources: the Department of Energy's *Energy Data Reports: Sales of Asphalt in 1980*, and 1980 U.S. Census Data. The DOE report provides asphalt consumption estimates by state. The census data were used to allocate to the five most populous boroughs a percentage of the total state asphalt consumption. Emission estimates for the five most populous boroughs are presented in Table 6-4. Activity data for this emission source are presented in Appendix C. Emissions from each of the asphalt types are discussed in greater detail below.

Asphalt Cement (Hot Mix) --

Application of asphalt cement results in the emission of 0.8 pounds total hydrocarbon per ton of asphalt applied (CARB, 1982a). Unfortunately, VOC speciation data for these emissions are unavailable. Therefore, it is assumed that VOC speciation data for asphalt plant emissions are applicable to asphalt usage.

Cutback Asphalts —

Three types of cutback asphalts are used: rapid cure, medium cure, and slow cure. Slow cure cutbacks are also known as road oils. None of the air toxics included in this study were identified in emissions from slow cure cutback asphalt. Analysis of emissions from medium cure asphalts showed toluene and xylene were 6.4% and 12.3%, respectively, of the total hydrocarbon emissions (Radian, 1985). Total hydrocarbon emissions from cutback asphalts were estimated to be 250 lb/ton asphalt (CARB 1982a). Unfortunately, the quantity of each type of cutback asphalt is not specified in the DOE report. Therefore, the total cutback asphalt quantity reported by DOE was assumed to be medium cure asphalt. This quantity was used in conjunction with 1980 consumption statistics to estimate emissions from cutback asphalt usage in Alaska.

TABLE 6-4.

ESTIMATED EMISSIONS FOR ASPHALT DISTRIBUTION AND USAGE

	Asphalt Type	Pollutant	Activity Data (Tons of Asphalt Applied)	Emissions (lb/yr)
Anchorage	Asphalt Cement	Benzene	24,265	1,868
		Formaldehyde	24,265	97
		PAH	24,265	19
	Cutback Asphalt	Toluene	1,433	22,928
		Xylene	1,433	44,136
	Road Oils	NTA*	85	N/A
	Emulsified Asphalt	N/A	3,688	N/A
Fairbanks	Asphalt Cement	Benzene	7,492	577
		Formaldehyde	7,492	30
		PAH	7,492	6
	Cutback Asphalt	Toluene	442	7,073
		Xylene	442	13,614
	Road Oils	NTA*	26	N/A
	Emulsified Asphalt	N/A	1,139	N/A
Juneau	Asphalt Cement	Benzene	2,740	211
		Formaldehyde	2,740	11
		PAH	2,740	2
	Cutback Asphalt	Toluene	162	2,592
		Xylene	162	4,990
	Road Oils	NTA*	10	N/A
	Emulsified Asphalt	N/A	416	N/A
Ketchikan Gateway	Asphalt Cement	Benzene	1,566	121
		Formaldehyde	1,566	6
		PAH	1,566	1
	Cutback Asphalt	Toluene	92	1,472
		Xylene	92	2,834
	Road Oils	NTA*	6	N/A
	Emulsified Asphalt	N/A	238	N/A
Sitka	Asphalt Cement	Benzene	1,062	82
		Formaldehyde	1,062	4
		PAH	1,062	1
	Cutback Asphalt	Toluene	63	1,008
		Xylene	63	1,940
	Road Oils	NTA*	4	N/A
	Emulsified Asphalt	N/A	161	N/A

* No air toxics were identified with this asphalt type.

Emulsified Asphalts —

These are essentially water-based asphalts and therefore have significantly lower hydrocarbon emissions than the other asphalt types. Air toxics emissions may occur from emulsified asphalts, but no information regarding air toxics on these emissions was identified in the literature reviewed.

Dry Cleaning

Area source estimates for dry cleaning include the smaller dry cleaning operations which are not covered in the point source estimates. There may be double counting because some of the smaller operations may contract with the larger plants that are included in the point source inventory or may serve as branch outlets which collect the clothes for cleaning at the central plant.

The only emission factor found for this source was 1.3 lb solvent/-capita/year (U.S. EPA, 1984a). Therefore population data were used to calculate emissions. Use of this emission factor assumes dry cleaning activity for Alaskans to be similar to the rest of the nation, which, as for any state, may or may not be accurate.

Generally, smaller operations use PCE as their dry cleaning solvent (U.S. EPA, 1984a). For this area source estimate, PCE was assumed to be the only solvent used. This may result in an overestimation of emissions because some operations contract with or serve as outlets for large stoddard plants. Area source emissions were calculated for Alaska's five largest population centers. Table 6-5 presents the emission estimates for dry cleaning.

Mobile Sources

Mobile sources that may potentially emit air toxics include cars, motorcycles, light trucks, and heavy duty commercial trucks, as well as off-highway mobile sources such as farm equipment, merchant vessels, locomotives, lawn and garden implements, snowmobiles, outboard motors, transport-refrigeration units, and helicopters. By far the most significant mobile source of emissions are on-highway vehicles including cars, motorcycles, and trucks.

Activity data for on-highway vehicles were compiled from total annual vehicle mileage estimates obtained from the Alaska Department of Transportation and U.S. Census Bureau Data. Total state automobile mileage for 1985 was estimated to be 3,788 x 10^6 miles; total truck mileage was estimated to be 1,090 x 10^6 miles. These mileage rates were apportioned to the five largest cities according to population. Furthermore, it was assumed that all truck miles correspond to diesel consumption.

Total hydrocarbon emissions from automobiles were calculated using an emission factor of 2.5 g/mile (Radian, 1985). Speciation data were compiled from SAI, 1982; and EPA, 1980. These data are presented in Appendix B.

TABLE 6-5.

PERCHLOROETHYLENE EMISSION ESTIMATES FOR DRY CLEANING

Area	Activity Data (Residential Population*)	Estimated Emissions (lb/yr)
Anchorage	170,247	220,000
Fairbanks	31,920	41,000
Juneau	19,528	25,000
Ketchikan-Gateway	7,198	9,400
Sitka	7,803	10,000

* 1980 Census Data

Tables 6-6 and 6-7 present the on-highway mobile source emission estimates for gasoline and diesel powered vehicles, respectively.

Pesticide Application

The application of pesticide results in emissions of some of the air toxics that are being investigated in this study. However, there are many pesticides that are toxic which were not included in the list of air toxics in the interest of keeping the list manageable. The compounds that are on the list that are potentially emitted from pesticide applications are listed below:

- arsenic,
- carbon tetrachloride,
- 1,4-dichlorobenzene,
- dibromoethane,
- dichloroethane,
- dioxins,
- lead arsenate,
- paratheon, and
- formaldehyde.

An EPA publication, Alaska Pesticides Profile, EPA 910/9-86-139, gives reported and estimated pesticide use by type and quantity. The estimated pesticide use in 1984 is presented in Table 6-8.

A review of this information and analysis of the most commonly used pesticide types indicate that the only significant use of a potentially air-toxics-emitting pesticide is the use of formaldehyde in fish hatcheries operations. A total of 1766 gallons were used in 1984.

Petroleum Marketing

Petroleum marketing sources include evaporation from automobile fuel tank refilling and from service station operations. The air toxics associated with petroleum marketing include benzene, ethylene dibromide, ethylene dichloride, toluene, and xylene. Emission factors for these contaminants were developed from the literature and are presented in Appendix B.

The activity data were based on total gasoline sales in Alaska for 1984 (DOE, 1986) and population data for 1980 (U.S. Census Bureau, 1980). Total state gasoline consumption was obtained from the Department of Energy's Energy Data Report for 1980. Consumption was apportioned to the boroughs on the basis of population data.

The emission estimates, however, may contain some error due to assuming that gasoline consumption is proportional to population. Many towns in Alaska have small road and street networks and therefore display different vehicle use characteristics. Juneau and Sitka are good examples where there are only 77 and 14 miles of paved road, respectively. Population-based gasoline

TABLE 6-6.

ESTIMATED MOBILE SOURCE EMISSIONS FOR ON-HIGHWAY GASOLINE VEHICLES

	Pollutant	Activity Data (Million-Vehicle Miles)	Emissions (lb/yr)
Anchorage	Benzene	1629	198,000
	Formaldehyde		520,000
	Toluene		950,000
	Xylene		244,000
	POM		NA
Fairbanks	Benzene	508	60,000
	Formaldehyde		158,000
	Toluene		292,000
	Xylene		74,000
	POM		NA
Juneau	Benzene	186	22,000
	Formaldehyde		58,000
	Toluene		106,000
	Xylene		28,000
	POM		NA
Ketchikan	Benzene	106	14,000
	Formaldehyde		32,000
	Toluene		60,000
	Xylene		16,000
	POM		NA
Sitka	Benzene	72	8,000
	Formaldehyde		22,000
	Toluene		42,000
	Xylene		10,000
	POM		NA

TABLE 6-7.

ESTIMATED MOBILE SOURCE EMISSIONS FOR ON-HIGHWAY DIESEL VEHICLES

	Pollutant	Activity Data (Million-Vehicle Miles)	Emissions (lb/yr)
Anchorage	Benzene	473	76,000
	Formaldehyde		488,000
	Toluene		72,000
	Xylene		12,000
	POM		NA
Fairbanks	Benzene	146	24,000
	Formaldehyde		150,000
	Toluene		22,000
	Xylene		4,000
	POM		NA
Juneau	Benzene	53	8,600
	Formaldehyde		56,000
	Toluene		8,000
	Xylene		1,400
	POM		NA
Ketchikan	Benzene	30	5,000
	Formaldehyde		32,000
	Toluene		4,600
	Xylene		800
	POM		NA
Sitka	Benzene	21	3,400
	Formaldehye		22,000
	Toluene		3,200
	Xylene		600
	POM		NA

TABLE 6-8.

ESTIMATED PESTICIDE USE IN ALASKA, 1984

Group	Gallons	Pounds
Fungicides	4,100	240
Wood Preservatives	--	500
Disinfectants	27,400	47,500
Biocides	59,600	—
Rodenticides	--	480
Insecticides	7,300	3,800
Herbicides	7,000	58,000
TOTAL	105,400	109,720

consumption estimates assume vehicle use proportionate to population, which may not be accurate in some cases. Appendix B illustrates the emission factors used to estimate emissions from petroleum marketing. As with gasoline evaporation point sources, the phase out of lead was taken into account in the development of emission factors for ethylene dibromide and ethylene dichloride. Emission estimates for petroleum marketing are shown in Table 6-9.

Residential Wood Combustion

Pollutant emissions from residential wood combustion (RWC) sources have caused impaired air quality in several Alaskan cities. For example it has been estimated that RWC sources contributed 80 percent of the fine particle mass observed at a site in Juneau in January and February of 1984 (Cooper et al., 1984). This area source is of special concern, because it emits several air toxics, including acetaldehyde, formaldehyde, benzene, phenol, cresol, POMs, and dioxins. Residential wood combustion also results in the emission of certain toxic metals; however, the emission factors for these elements are very small. For that reason, metals emissions are considered insignificant and are not included in this inventory.

Estimates of the extent of wood use in residential stoves and fireplaces in Anchorage, Fairbanks, and Juneau were derived from wood use surveys conducted by air pollution control districts in those cities. The results of these surveys were used to derive estimates of the fractions of homes using wood as fuel and the total amount of wood burned in stoves and fireplaces. These values were then combined with U.S. Department of Commerce census data from 1980 to yield estimates of the total amount of wood consumed in each type of combustion device.

The average wood consumption rate per wood stove in Anchorage was assumed to be equal to the average fireplace consumption rate of 0.35 cords per year. Compared to other geographic areas in Alaska, 0.35 cords of wood consumed per wood stove may seem low. However, this activity data was chosen based on a consideration of the economics of burning wood in Anchorage. Because of the unavailability of natural gas in Anchorage, it is cheaper to heat homes in Anchorage that other parts of Alaska. In addition, wood is more expensive in Anchorage due to its relative scarcity as compared to other areas. These two factors are believed to depress the demand for wood stove heat in Anchorage.

Survey data for Sitka and Kitchikan were not available. Because Juneau, Sitka, and Ketchikan are all in the southeast part of the state, the survey results for Juneau were assumed to apply to Sitka and Ketchikan as well. The survey results and wood use estimates are described further in Appendix C.

The activity data derived from the surveys and census data were combined with emission factors (see Appendix B) to estimate emissions. Table 6-10 presents the emission estimates for each city.

TABLE 6-9.

ESTIMATED EMISSIONS FOR PETROLEUM MARKETING

	Pollutant	Activity Data (Million-Gallons)	Emissions (lb/yr)
Anchorage	Benzene	97.05	32,220
	EDB	39.98	1.15
	EDC	39.98	7.66
	Toluene	97.05	21,252
	Xylene	97.05	6,440
Fairbanks	Benzene	29.96	9,942
	EDB	12.34	0.33
	EDC	12.34	2.39
	Toluene	29.96	6,562
	Xylene	29.96	1,988
Juneau	Benzene	10.96	3,636
	EDB	4.52	0.16
	EDC	4.52	0.82
	Toluene	10.96	2,400
	Xylene	10.96	728
Ketchikan	Benzene	6.26	2,078
	EDB	2.58	0.08
	EDC	2.58	0.49
	Toluene	6.26	1,372
	Xylene	6.26	416
Sitka	Benzene	4.25	1,410
	EDB	1.75	0.08
	EDC	1.75	0.33
	Toluene	4.25	930
	Xylene	4.25	282

Note: EDB = Ethylene Dibromide
EDC = Ethylene Dichloride

Slash Burning and Forest Fires

Combustion of vegetation such as that which occurs during slash burning and forest fires can produce a variety of air toxic emissions. However, emission factors for this source are not well characterized. In addition, data on the total acreage burned are not readily available. For these reasons, emission estimates for each region of Alaska have not been developed. However, preliminary estimates of emissions for slash burning have been developed for the Fairbanks and Anchorage (Mat-Su/Kenai) areas. These estimates are based on information received from the ADEC staff on the acreage permitted for slash burning. Emission factors used for POMs and manganese were reported by McMahon and Tsoukalas (1978) and Ward and Hardy (1984). The estimates are shown in Table 6-11.

TABLE 6-10.

SUMMARY OF ESTIMATED POLLUTANT EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION

	Estimated Emission Rate (lb/yr)				
Pollutant	Anchorage[b]	Fairbanks North Star	Juneau	Ketchikan	Sitka
Acetaldehyde	490	11,000	4,400	2,500	1,500
Benzene[a]	83	1,900	690	390	240
Cresols	1,200	27,000	9,900	5,600	3,400
Dioxins[a]	0.00034	0.0078	0.0022	0.0012	0.00076
Formaldehyde	970	22,000	9,200	5,200	3,200
Phenol	1,500	34,000	12,000	7,000	4,300
POM	1,000	24,000	9,000	4,900	3,000

a) Emission estimates for these species only include the contributions from wood-burning stoves - emission factors for fireplaces were not available.

b) The recent popularity of wood stoves and the growth in the number of housing units in Anchorage since 1980 may result in an underestimation of the number of wood stoves and the amount of wood burned.

TABLE 6-11.

POM AND MANGANESE EMISSIONS FROM SLASH BURNING

Area	Emission Rate lb/year)	
	POMs	Manganese
Fairbanks	290	15
Anchorage		
Kenai Peninsula	1,600	83
Matanuska-Susitna Valley	13,000	680

SECTION 7

RANKING OF POINT AND AREA SOURCES

This section presents the methodology and results of ranking the point and area sources according to their relative health risk.

The ranking procedure presented below simply ranks sources. Quantitative health implications cannot be determined from this information. The ranking method does not account for the dispersion of pollutants, which is greatly affected by stack parameters (e.g., gas temperature, stack height, etc.) and local meteorology. Furthermore, the ranking does not account for exposure pathways or dose response relationships which influence the actual exposures to air toxics and the associated risks. However, this ranking procedure provides the necessary focus for future consideration in reducing, if necessary, the health risk associated with the chemicals identified in the inventory.

Ranking Methodology

To rank the point sources, the magnitude of the emissions and the relative toxicity of the emissions are taken into account. A ranking factor for each source was developed by multiplying the emissions of each source by a measure of the toxicity of each pollutant emitted.

The same approach was used for area sources; however, it should be recognized that point and area sources were not directly comparable in this ranking. Point sources impact the general population immediately surrounding the source. On the other hand, area sources are much more dispersed, potentially resulting in vastly different exposure levels to the general population. Because of this difference in exposure levels, area sources are ranked separately from point sources.

There are two ways in which the relative toxicity of the pollutants can be taken into account. One way is to use potency slope values developed by EPA's Carcinogenic Assessment Group. These values, expressed in the units of time per mass of pollutant per mass of body weight, refer to the slope of a dose response curve. The dose-response relationship represents the individual risk of contracting cancer at a specified dose level in a test group of animals. Using a statistical model, this relationship is extrapolated to very low doses (associated with environmental exposure) to represent the individual risk of contracting cancer in humans.

Potency slope values do not exist for 13 of the 26 air toxics compounds inventoried in the state of Alaska. Many of these 13 compounds are not considered carcinogens, which accounts for the lack of potency slope data.

A second approach would be to use Threshold Limit Values (TLVs) as a measure of relative risk. Because TLVs exist for each of the pollutants in this study, the TLVs were chosen over potency slope values to provide a more thorough ranking.

TLVs are expressed as airborne concentrations and are intended to protect most workers from adverse health effects when exposed to certain chemicals eight hours per day, five days per week. Obviously this exposure rate can be quite different than the exposure rate to ambient concentrations of air toxics. In fact, the American Conference of Governmental Industrial Hygienists (ACGIH), which recommends TLVs, states that TLVs are not intended for uses other than the evaluation of workplace exposures by industrial hygienists. That is, TLVs are not intended to evaluate community air pollution, or extended, uninterrupted periods of exposures.

In recognition of these caveats, it should be noted that TLVs are not used in this study for the evaluation of airborne contaminants. TLVs are used as relative toxicity indicators for ranking emission sources. The assumption implied here is that lower TLVs indicate that those particular chemicals are more toxic. Table 7-1 presents the TLV values.

In summary, the sources were ranked by multiplying the emission estimate for each pollutant times the TLV for that pollutant. When more than one pollutant is emitted by a source type, the products of these two values were summed together. This concept is illustrated below:

$$\text{Ranking factor} = \sum_{i=1}^{n} (\text{emissions}_i)\ (1/\text{TLV}_i)$$

Where i = each individual pollutant and
n = number of pollutants emitted by each source type

In order to use TLVs, 1/TLV must be used. Increased emission levels indicate increased health impact, whereas higher TLV values indicate decreased health impact. For this reason, 1/TLV was used.

For several of the pollutants (primarily dioxins/furans, PAH, and chromium) the emission factors used in this inventory estimate gross emissions for several species of pollutants (i.e., benzo(a)pyrene is a constituent of PAH). The ranking methodology then multiplies the emissions by a TLV that was developed for a specific constituent that comprises only a portion of the emission estimate. For example, total dioxin and furan emissions were estimated for municipal waste incineration, but only a portion of these emissions are known to be the higher toxic 2,3,7,8 TCDD. A similar situation exists with PAH where benzo(a)pryene is a primary concern and with chromium where chromium in the hexavalent rather than the trivalent oxidation state is the primary concern. Unfortunately, insufficient information exists to accurately speciate the emissions estimates. Therefore, using TLVs developed for specific pollutants overstates the ranking factor calculated for sources of dioxins/furans, PAH, and chromium (for combustion sources only). In the case of dioxins/furans, the TLV is expected to overstate the ranking factor by 80 to 90 percent. For chromium emissions resulting from combustion sources, hexavalent chromium is believed to comprise less than 10 percent of the total

TABLE 7-1.

TOXICITY WEIGHTING DATA FOR AIR TOXICS EMITTED IN ALASKA

Metals	TLV (mg/m^3)	Potency Slope (mg/kg/day)$^{-1}$
Acetaldehyde	180	N/A
Arsenic	0.2	50
Benzene	30	0.029
Beryllium	0.002	2.6
Cadmium	0.05	6.1
Chromium	0.05	41
Chloroform	50	0.081
Cresols	22	N/A
Dibenzofuran	N/A	N/A
Dioxins	30×10^{-9}[a]	1.56×10^{5}
Ethylene Dibromide	1.0[b]	41
Ethylene Dichloride	40	0.091
Ethylene Oxide	2	N/A
Formaldehyde	1.5	N/A
Freon 113	7,600	N/A
Lead	0.15	N/A
Manganese	5	N/A
Mercury	0.05	N/A
Nickel	0.1[e]	2.1[d]
PAH/POM	0.2[c]	11.5[f]
Perchloroethylene	335	0.051
PCB	0.5	4.34
Phenol	19	N/A
Uranium	0.2	N/A
Toluene	375	N/A
Xylene	435[g]	N/A

TABLE 7-1 (Continued)

Footnotes:

[a] Concentration recommended by the Ontario Ministry of the Environment, as cited in "Health Effects of 2,3,7,8-Tetrachlorodibenze-P-Dioxin and Related Compounds," prepared by the Epidemiological Studies and Surveillance section, Department of Health Services, Berkeley, California, February 1986.

[b] Concentration recommended by the National Institute for Occupational Safety and Health. See NIOSH recommendations for Occupational Safety and Health Standards, July19, 1985, Vol. 34/No. 15.

[c] TLV for soluble compounds, as nickel.

[d] Nickel as the subsulfide.

e TLV for coal tar pitch volatiles, as benzene solubles.

[f] Potency slope for benzo(a)pyrene.

[g] O-,m-,p-isomers of xylene.

chromium emissions; thus, overstating the ranking factor by at least 90 percent. Insufficient information is available to make a similar statement for PAH.

As a final point, a specific emission factor for dibenzofuran was used for sewage sludge incineration. This is a compound dibenzofuran and not the family of highly toxic chlorinated furans. A TLV for dibenzofuran is not available. The emission of this compound are not included in the ranking of sources.

Ranking Results

Detailed results of the point source ranking are shown in Appendix E. A summary of these results is shown in Table 7-2 by source category. Tables 7-3 and 7-4 present the individual results of the point and area source ranking.

Table 7-3 indicates the highest priority point sources are combustion sources. We believe this may be somewhat misleading because the dispersion potential of these sources were not taken into account. Combustion sources often have taller stacks and elevated stack gas temperatures than noncombustion sources, resulting in greater dispersion.

TABLE 7-2.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK

Source Type	Ranking Factor	Number of Facilities	Comments
1. Municipal Solid Waste Incineration	1,100,000	8	Includes only those facilities burning more than 300 tpy.
2. Diesel Turbine Engines	250,000	14	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
3. Industrial Wood Combustion	150,000	5	Ranking does not take into account aldehyde emissions, which are unknown.
4. Distillate Oil Combustion	54,000	13	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
5. Reciprocating Diesel Engines	69,000	58	Includes only those facilities that are emitting more than 2 tpy of PM or VOC.
6. Coal Combustion	47,000	7	Ranking factor based on 1979 activity data.
7. Waste Oil Combustion	23,000	8	Ranking factor does not include three facilities. Activity data for these four facilities are unknown.
8. Gasoline Evaporation	2,700	23	Ranking factor based on 1979 activity data.

Continued

TABLE 7-2.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK (Continued)

Source Type	Ranking Factor	Number of Facilities	Comments
9. Pulp and Paper Mills	1,300	2	Ranking accounts for emissions from wastewater treatment.
10. Ethylene Oxide Sterilization	900	10	Ranking factor assumes all emissions are emitted at the hospital, which is not necessarily the case. A portion of the EtO is emitted from sewer lines.
11. Battery Manufacturing	900	1	Ranking does not take into account arsenic and chromium emissions.
12. Cooling Towers	600	2	Chloroform emissions from two other cooling towers are unknown. Ranking factor also does not include smaller cooling tower used for cooling.
13. Municipal Sewage Incineration	500	1	Ranking based on Anchorage water and sewer facility only. Other incinerators in the state were found to have insignificant air toxics emissions.
14. Airports	480	6	Ranking based on six largest commercial airports. Emissions from military installations and non-commercial flights are not accounted for.

Continued

TABLE 7-2.

POINT SOURCE CATEGORIES RANKED ACCORDING TO RELATIVE HEALTH RISK (Continued)

Source Type	Ranking Factor	Number of Facilities	Comments
15. Hot Mix Asphalt Production	460	29	Ranking factor does not include six facilities from the south east portion of the state. The activity data for these facilities are unknown.
16. Residual Oil Combustion	430	1	Includes only facility emitting more than 2 tpy of PM or VOC.
17. Oil Refinery Fugitives	330	9	Ranking based on emission estimates calculated from production data obtained primarily from the Oil and Gas Journal.
18. Perchloroethylene Dry Cleaning	160	2	See also area source rankings.
19. Electroplating	140	2	Emission estimate for two of four facilities available.
20. Portland Cement Manufacturing	5	1	
21. Paint Manufacturing	21	1	
22. Freon Dry Cleaning	0	1	Emissions are unknown. However, ranking factor expected to be a small value due to low toxicity of CFC-113.

Notes:

a) Sources are ranked according to their relative toxicity using threshold limit values.

b) Point source ranking factors are not directly comparable to area source ranking factors due to the diverse, widespread nature of area source emissions.

TABLE 7-3.

FACILITIES WITH RANKING FACTORS GREATER THAN 5,000

Source Type	Facility	Ranking Factor
Coal Combustion	U.S. Army Ft. Wainwright-Fairbanks	30,000
	Golden Valley Electric Assn-Healy	6,200
Distillate Oil Combustion	U.S Navy ADAK Navel Air Stn-ADAK	25,000
	U.S. Army Ft. Wainwright-Fairbanks	30,000
	Golden Valley Electric Assn-Healy	6,200
Municipal Waste Incineration	North Slope Borough	480,700
	Channel Landfill-Juneau	450,000
	City of Sitka	84,000
	Hacor-Anchorage	33,000
	USAF Shemya AFT-Shemya	29,000
	City of Whittier	9,900
	Alyeska Pipeline/Pump Station #3-Sagavanirtok	9,000
	USAF King Salmon AFT	8,400
Reciprocating Diesel Engines	Kodiak Electric Assn-Kodiak Island	7,100
Turbine Diesel Engines	Alyeska Pipeline Pump Station #11-Copper Center	41,000
	Alyeska Pipeline Pump Station #10-Black Rapids	40,000
	Alyeska Pipeline Pump Station #7-Livengood	38,000
	Alyeska Pipeline Pump Station #8-Fairbanks	37,000
	Alyeska Pipeline Pump Station #9-Delta	34,000
	Alyeska Pipeline Pump Station #6-Yukan River	34,000
	Alyeska Pipeline Station #5-Propsect	19,000
	Alyeska Marine Terminal-Valdez	7,600
Wood Combustion	Ketchikan Pulpco-Ketchikan	84,000
	Alaska Pulp Corp-Sitka	34,000
	Wrangel Forest Products-Wrangell	28,000

TABLE 7-4.

RANKING FACTORS FOR AREA SOURCE CATEGORIES

Area Source	Anchorage	Fairbanks	Juneau	Ketchikan Gateway	Sitka
Asphalt Distribution and Usage	380	120	43	24	18
Dry Cleaning	660	120	75	28	30
Mobile Sources	690,000	210,000	80,000	44,000	30,000
Petroleum Marketing	1,100	350	130	73	50
Residential Wood Combustion	8,600	200,000	120,000	68,000	41,000
Slash Burning	73,000[c]	1,900	NA	NA	NA

Notes:

a) Ranking factors are based on threshold limit values.

b) Area source ranking factors are not directly comparable to point source ranking factors due to the diverse, widespread nature of areas source emissions.

c) NA indicates not applicable.

d) Kenia Peninsula = 8,000 and Matanuska-Susitna Valley = 65,000

SECTION 8

SOURCE TESTING AND AMBIENT AIR MONITORING OF AIR TOXICS

The measurement of airborne pollutants is a complex subject. The scope of this study prevents a detailed discussion of source testing and ambient air monitoring of air toxics. This section provides a brief overview and summary of the methods and techniques used to measure air toxics. We first discuss sampling and monitoring techniques and conclude with a summary of analytical methods.

Information presented here will be useful in selecting appropriate sampling and analytical methods. However, the applicability of any given method should be carefully investigated before it is used. A separate bibliography pertaining to the measurement of airborne pollutants is provided at the end of this section for further reference.

SOURCE TESTING TECHNIQUES

Organic Source Testing

Source testing of organic emissions can be conducted using one of two generic methods: fixed volume grab sampling or concentration of organics using sorbent trap. Fixed volume grab sampling usually involves employing one of the following specific methods:

- syringe,
- flow-through bottle,
- evacuated canister,
- Tedlar® bags (EPA Method 3), or
- EPA Method 25.

These methods are typically used for non-combustion or low moisture content combustion emissions. Further, they have the advantages of low cost, applicable to high organic content emissions, and can provide useful information when short-term emission events need to be defined.

A major disadvantage for fixed volume grab sampling is that this method does not provide extremely low detection limits. In those instances requiring low detection limits, concentration of organics using the following specific methods may be employed:

- Volatile Organic Sampling Train,
- Modified Method 5,
- High Volume Modified Method 5, and
- Source Assessment Sampling System.

These methods are commonly used for the measurement of combustion emissions. A sorbent is used to collect and concentrate the organic constituents. The sorbent is then transported to the laboratory, where the constituents are desorbed and analyzed. Table 8-1 summarizes organic source testing techniques.

Inorganic Source Testing

Source testing for inorganic pollutants primarily involves collecting particulate matter and then analyzing the collected sample for its individual constituents. EPA Method 5, Determination of Particulate Emissions from Stationary Sources, is the accepted basic method for measuring inorganic emissions (40 CFR Part 60, App. A).

Method 5 utilizes a glass fiber filter maintained at approximately 120°C to capture particulate matter. The sample then flows through a series of impingers containing distilled water to capture additional inorganic material. In the case of mercury and arsenic, which may pass through the sampling train in the gaseous phase, special sorbents may be used in the impingers to absorb these compounds out of the flue gas. For mercury, potassium permanganate may be used when sampling combustion emissions (40 CFR, Part 60, App. B, Method 101A). In the case of arsenic, impingers containing nitric acid, hydrogen peroxide, and sodium hydroxide have been used (U.S. EPA, 1978a).

AMBIENT AIR MONITORING TECHNIQUES

Organic Monitoring

In April, 1984, EPA published a methods compendium to provide regional, state, and local environmental regulatory agencies, as well as other interested parties, with specific guidance on the determination of selected toxic organic compounds in ambient air (U.S. EPA, 1984). The methods compendium consists of five methods which are considered to be of primary importance in toxic organic monitoring efforts. Table 8-2 presents a description of the five ambient monitoring methods. Detailed descriptions of the methods are available in the methods compendium. A summary of the toxic organic compounds that have been evaluated by each method is presented in Table 8-3.

Analysis of Table 8-3 indicates that many of the toxic organic compounds compiled in the Alaska air toxics inventory have been evaluated by one or more of the methods included in the compendium. In addition, some of the compounds that have not been specifically evaluated have similar characteristics to evaluated compounds. We expect that these compounds may also be evaluated by the methods described in the compendium although the applicability of any given method should be carefully considered before use.

For example, Radian is currently using the PUF method to monitor for dioxins and furans in Southern California. To assure that dioxins/furans in the gaseous state are monitored, the method has been modified slightly by sandwiching a layer of XAD resin between layers of polyurethane.

TABLE 8-1.

SUMMARY OF SOURCE TESTING METHODS FOR ORGANIC AIR TOXICS

Sampling method	Description	Applicable source type	Applicable compound type	Applicable analytical method(s)	Sampling method limitations
Syringe	Instantaneous grab	Non-combustion (storage tanks, spray booths, paint bake ovens, etc.).	Volatiles, C_1-C_{10}	GC-FID[a]/MS[b]	Sample size and therefore detectable concentration are limited by container size; ≥ 1 ppm.
Flow-through bottle	Instantaneous grab	Same as above.	Volatiles, C_1-C_{10}	GC-FID/MS	Same as above
Evacuated canister	Integrated grab	Low moisture content combustion emissions (boilers, dry control incinerators, etc.).	Volatiles, C_1-C_{10}	GC-PID[c]	Same as above
Tedlar® bag (EPA Method 3)	Integrated grab	Same as above.	Volatiles, C_1-C_{10}	GC-FID/MS	Bag Samples are subject to absorptive losses of sample components.
EPA Method 25	Two stage integrated grab train consisting of cold trap followed by evacuated S.S. tank.	Non-combustion and low moisture content combustion emissions as above.	Volatiles and semi-volatiles, C_1-C_{16}	Oxidation/ reduction to CH followed by GC/FID.	Sample size is limited by tank volume. CO_2 and H_2O can produce significant interferences. System is complex/ cumbersome.
VOST[d]	Water-cooled sample gas, including condensate, is passed through dual in-series sorbent traps. Tenax G.C.® in first tube followed by Tenax G.C.® backed-up by charcoal in second tube.	Combustion emissions (boilers, hazardous waste incinerators, etc.).	Volatiles and semi-volatiles, C_1-C_{16}, Cl_1-Cl_{10}	GC-MS, GC-ECD, GC-PID	Sample size is limited to 20 liters per pair of sorbent tubes. Sorbent tubes are susceptible to contamination from organics in ambient air during installation and removal from train.
Modified Method 5	Water-cooled sample gas, with condensate is passed through single sorbent trap. Sorbent type dependent on compound(s) of interest.[e]	Combustion emissions as for VOST.	Semi-volatiles, PCBs, other halogenated organics, C_7-C_{16}, Cl_1-Cl_{10}	GC-ECD, GC-HECD, GC-MS	Single trap system does not provide check for breakthrough. Flow rate limited to approximately 1 cfm.

Continued

TABLE 8-1.

SUMMARY OF SOURCE TESTING METHODS FOR ORGANIC AIR TOXICS (Continued)

Sampling method	Description	Applicable source type	Applicable compound type	Applicable analytical method(s)	Sampling method limitations
High volume modified Method 5	Sample gas is passed through condensers where moisture is removed before passing through two sorbent traps, primary followed by back-up. Flow rates of up to 5 cfm are achievable. Sorbent type dependent on compounds of interest.[e]	Combustion emissions.	Semi-volatiles, PCBs, other halogenated organics, C_7-C_{16}, Cl_1-Cl_{10}	GC-ECD, GC-HECD, GC-MS	High flow rate results in high sampling train pressure drop requiring large pump capacity.
SASS train	Sample Gas passes through a cold trap followed by an XAD-2 sorbent trap. Train is all stainless steel construction.	Combustion emissions (boilers, hazardous waste incinerators).	Semi-volatiles, and other non-halogenated organics, C_7-C_{16}	GC-ECD, GC-HECD, GC-MS	System is complex, large and cumbersome. Recovery of organics from cold trap can be difficult. S.S. construction makes train components highly susceptible to corrosion from acid gases, especially HCL.

[a] GC-FID - gas chromatography with flame ionization detector.
[b] GC-MS - gas chromatography-mass spectrometry.
[c] GC-PID - gas chromatography-photoionization detector.
[d] VOST - volatile organic sampling train.
[e] Sorbents include Florisil®, XAD-2® resin, and Tenax-GC® among the most commonly used.

Source: Polcyn, 1985

TABLE 8-2.

SUMMARY OF AMBIENT SAMPLING AND ANALYSIS METHODS FOR TOXIC ORGANICS

Method Number	Method	Description	Types of Compounds Determined
TO-1	Tenax GC Adsorption and GC/MS Analysis	Volatile organic compounds are adsorbed onto Tenax® resin. Highly volatile compounds and inorganic constituents pass through resin. Collected sample is placed in a heated chamber and purged with inert gas. Inert gas transfers organics to a cold trap and subsequently to a GC column.	Volatile, nonpolar organics (e.g. aromatic hydrocarbons, chlorinated hydrocarbons) having boiling points in the range of 80 to 200°C.
TO-2	Carbon Molecular Sieve Adsorption and GC/MS Analysis	Volatile organic compounds are adsorbed onto carbon molecular sieve (CMS) adsorbent. Major inorganic constituents pass through adsorbent. Collected sample is purged with dry air to remove moisture and then purged with helium at 350-400° C. Desorbed compounds are collected in cryogenic trap and then flash evaporated into GC/MS system.	Highly volatile, nonpolar organics (e.g. vinyl chloride, vinylidene chloride, benzene, toluene) having boiling points in the range of -15 to + 120°C.
TO-3	Cryogenic Trapping and GC/FID or ECD Analysis	A collection trap is submerged in either liquid oxygen or argon. Ambient air is emitted to the collection device. Once collection is complete a carrier gas sweeps the contents of the trap onto the head of a cooled GC column. Simultaneously, the crygen is removed and the trap is heated to assist sample transfer.	Volatile, nonpolar organics having boiling points in the range of -10 to + 200°C.

Continued

TABLE 8-2.

SUMMARY OF AMBIENT SAMPLING AND ANALYSIS METHODS FOR TOXIC ORGANICS[1] (Continued)

Method Number	Method	Description	Types of Compounds Determined
TO-4	High volume PUF Sampling and GC/ECD Analysis	A modified high volume sampler is used. A glass fiber filter with a polyurethane (PUF) backup absorbent cartridge is used to collect sample. Soxhlet extraction is used to recover sample from filter and PUF cartridge.	Organochlorine pesticides and PCBs
TO-5	Dinitrophenylhydrazine Liquid Impinger Sampling and HPLC/UV Analysis	Sample is drawn through impingers containing HCl, DNPH reagent, and isooctane. The sample is evaporated to dryness under a stream of nitrogen and dissolved in methanol.	Aldehydes and Ketones

Source: EPA, 1984

TABLE 8-3.

SUMMARY OF TOXIC ORGANIC COMPOUNDS FOR WHICH AMBIENT SAMPLING AND METHODS HAVE BEEN EVALUATED

Method	TO-1	TO-2	TO-3	TO-4	TO-5
Compounds Evaluated:	Benzene	Vinyl Chloride	Vinylidene Chloide	Aldrin	Formaldehyde
	Toluene	Acrylonitrile	Chloroform	4,4'-DDE	Acetaldehyde
	Ethyl Benzene	Vinylidene Chloride	1,2-Dichloroethane	4,4'-DDT	Acrolein
	Xylene(s)	Methylene Chloride	Methylchloroform	Chlordane	Acetone
	Cumene	Allyl Chloride	Benzene	Chlorobiphenyls	Crotonaldehyde
	n-Heptane	Chloroform	Trichloroethylene	4,4'Di-	Isobutyraldehyde
	1-Heptene	1,2-Dichloroethane	Tetrachloroethylene	2,4,5 Tri-	Methyl Ethyl Keton
	Chloroform	1,1,1-Trichloroethane	Chlorobenzene	2,4',5 Tri-	Benzaldehyde
	Carbon Tetrachloride	Benzene		2,2',5,5' Tetra-	Pentanal
	1,2-Dichloroethane	Carbon Tetrachloride		2,2',4,4',5,5' Hexa-	o-Tolualdehyde
	1,1,1-Trichloroethane	Toluene			m-Tolualdehyde
	Tetrachloroethylene				p-Tolualdehyde
	Trichloroethylene				Hexanal
	1,2-Dichloropropane				
	1,3-Dichloropropane				
	Chlorobenzene				
	Bromoform				
	Ethylene Dibromide				
	Bromobenzene				

Source: EPA, 1984

Inorganics Monitoring

Metals are generally present in the ambient air as constituents of particulate matter. Some metals such as arsenic, mercury, and selenium may also be present in the vapor phase under normal ambient conditions. Sample collection and analysis methods for both particulate and vapor phase metals are briefly discussed below.

Sample collection methods for inorganic air toxics are similar to those used for the criteria pollutant particulate matter. Suspended particulates in the ambient air are collected on a filter for 24 hours using a high volume air sampler. The filter is then transported to a laboratory for subsequent analysis.

Airborne mercury (Hg) occurs as a number of volatile chemical species including elemental Hg, $HgCl_2$ and alkylated mercury compounds. Consequently, the particulate bound fraction of mercury in the atmosphere is often less than 10% of the total (Brauman, 1983). Arsenic is another toxic metal with a significant vapor component in the form of arsenic trioxide or methylated arsenic. Significant undersampling of mercury and arsenic may occur if the particulate filtration sample collection technique is used alone.

Volatile forms of mercury and arsenic can be collected by adding a series of adsorbents to the particulate sampling train. The adsorbent can be enclosed in a tube or impregnated into a standard filter medium. The tubes or impregnated filters are mounted in plastic holders and positioned downstream from the particulate filter. With this arrangement, particulate matter and vapor phase metals are collected from the same sample.

ANALYTICAL TECHNIQUES

Organics Analysis

There are numerous analytical techniques that can be used to quantify organic constituents in a collected sample. The more common and accepted analytical methods are summarized in Table 8-4. Selection of the appropriate analytical method is based on determination of the following factors (Polcyn, 1985):

- Which constituents are of greatest interest?
- What is the needed level of detection?
- What is the minimum sample size required to achieve desired detection levels?
- What, if any, interfering compounds may be present?
- Which sampling techniques are compatible with the preferred analytical method(s)?

TABLE 8-4.

SUMMARY OF ANALYTICAL METHODS FOR ORGANIC AIR TOXICS

Analytical Method	Compound Applicability	IDL^a (pg/m^3)	Sample Preparation	Method Notes
Gas Chromatography (GC) Flame ionization detection (FID)	Non-halogenated VOC, polynuclear aromatic hydrcarbons (PAHs)	5-10	Direct injection, Liquid Liquid extraction	Response varies with different compounds - not suitable for mixtures of numerous (>3) compounds.
	Acrolein, acrylonitrile acetonitrile	25-100		
Photoionization detection (PID)	Aromatic VOC	0.1-1	Direct injection	Excellent field screening method but at higher detection level.
Hall electrolytic conductivity detection (HECD)	Halogenated VOC	1-10	Soxhlet extraction, purge and trap	Very halogen specific. It is very capable of achieving very low-detection levels even when mixtures of numerous chlorinated compounds are present.
Electron capture detection (ECD)	Chlorinated hydrocarbons, polychlorinated biphenyls (PCB), organochlorine pesticides, cycloketones, phthalate esters, nitroaromatics	1-1000	Soxhlet extraction, purge and trap	Also highly halogen specific.

Continued

TABLE 8-4.

SUMMARY OF ANALYTICAL METHODS FOR ORGANIC AIR TOXICS (Continued)

Analytical Method	Compound Applicability	IDL[a] (pg/m^3)	Sample Preparation	Method Notes
Gas Chromatography-mass spectrometry (GC/MS)	VOC, semi-VOC, PCB, halogens, PCDD, PCDF, etc.	100-1000	Soxhlet extraction, purge and trap	Ideal for identifying and quanitifying individual compounds in a mixture of numerous compounds.
High Performance liquid chromatography (HPLC)[b]	PAH	0.1-1	Liquid-liquid extraction, soxhlet extraction	Highly specific for certain polynuclear aromatic hydrocarbons.
Atmospheric pressure chemical ionization mass spectrometry (APCI-MS)	VOC, semi-VOC, PCB, halogens, PCDD, PCDF, etc.	100	Direct injection	Can be mounted in mobile laboratory for on-site analysis. Mobile capability has been demonstrated.

[a] IDL - instrument detection limit; values given (in picograms/cubic meter) are ranges based on the median value for the range of applicable compounds listed.

[b] With flourescense detector.

Source: Polcyn, 1985.

The most versatile analytical tool listed in Table 8-4 is gas chromatography with mass spectrometry (GC/MS). This method is capable of detecting organic compounds independent of their chemical or electrical characteristics. A GC/MS computer library will rapidly and automatically identify thousands of compounds by mass character rather than by chemical composition.

Inorganics Analysis

Inorganic sample analysis is generally a two step process which typically consists of nitric acid digestion. Following digestion, the sample can be analyzed using standard atomic absorption (AA) or inductively coupled plasma emission spectroscopy (ICPES). In general, ICPES is a less costly analytical method than atomic absorption. However, for arsenic, lead, mercury, and selenium, the detection limit of ICPES is generally insufficient. Consequently, atomic absorption is used for these four metals.

Alternately, the sample can be analyzed using x-ray fluorescence (XRF) analysis. This technique involves the bombardment of a thin layer of sample by high energy x-rays. Excited atoms of a particular metal then emit fluorescent x-ray radiation with a characteristic wavelength. The intensity of this radiation can be used to determine the concentration of the constituent.

Analysis of chromium represents a special case. Hexavalent chromium is much more toxic than chromium in the trivalent oxidation state. Therefore, it is often necessary to determine the fraction of chromium present in the hexavalent oxidation state. Total chromium can be determined using the techniques listed above, but hexavalent chromium requires a different method. Under acidic conditions, hexavalent chromium is reduced to the trivalent state. As a result, alkaline digestion rather than acidic digestion must be used. Butler, et al. (1986) summarized this method for particulate matter in a recently published journal article. A similar method is presented in Test Methods for Evaluating Solid Wastes (U.S. EPA, 1982a).

QUALITY CONTROL

Appropriate quality control procedures must be established and maintained to ensure reliable analytical results. This generally involves developing a quality assurance project plan (U.S. EPA, 1980). Such a plan documents in detail the quality assurance procedures that will be used in collecting and analyzing the samples. If more than one site is to be sampled, site specific test plans should be developed documenting the activities that will be performed at each location.

It is essential that a quality assurance project plan address the following items:

- Pre-test Quality Control. Sample collection equipment and sample containers should be appropriately cleaned, packaged, and stored to prevent contamination. This involves a combination of washing, solvent rinsing, and baking the sample containers in the case of organic sampling.

- On-site Quality Control. To prevent sample contamination, duplicate samples, field blanks, and control samples must be used. To prevent loss, each sample must be labeled, handled, and stored properly.

- Transportation Quality Control. Sample custody must be established to ensure the proper transfer of samples from field personnel to laboratory personnel. This requires written documentation detailing the custody, location, method of transfer, time and data of collection and transfer, and a description of the samples (number of samples, size, type, field preservation, etc.).

- Laboratory Quality Control. Proper handling, storage, and preparation techniques must be established and maintained. Laboratory blanks and surrogate spiking must also be used.

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SECTION 9

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APPENDIX A

POINT SOURCE EMISSION ESTIMATES

ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	#	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
1041	GOLD MINING	RECIPROCATING DIESEL ENG	AK GOLD CO-NOME		CHROMIUM	.000007 LB/GAL	168000	1	1.2
					MANGANESE	.000004 LB/GAL	168000	1	0.67
					NICKEL	.00014 LB/GAL	168000	1	24
					PAH	.0000014 LB/GAL	168000	1	0.24
					FORMALDEHYDE	.0001 LB/GAL	168000	1	17
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	STANDARD ALASKA PROD CO-BARROW		CHROMIUM	.000007 LB/GAL	318000	1	2.2
					MANGANESE	.000004 LB/GAL	318000	1	1.3
					NICKEL	.00014 LB/GAL	318000	1	45
					PAH	.0000014 LB/GAL	318000	1	0.45
					FORMALDEHYDE	.0001 LB/GAL	318000	1	32
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	AMOCO PRODUCTION CO-KENAI PENINSULA		CHROMIUM	.000007 LB/GAL	CONF	1	
					MANGANESE	.000004 LB/GAL	CONF	1	
					NICKEL	.00014 LB/GAL	CONF	1	
					PAH	.0000014 LB/GAL	CONF	1	
					FORMALDEHYDE	.0001 LB/GAL	CONF	1	
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	AMOCO/BAKER-COOK INLET		CHROMIUM	.000007 LB/GAL	150000	1	1.1
					MANGANESE	.000004 LB/GAL	150000	1	0.60
					NICKEL	.00014 LB/GAL	150000	1	21
					PAH	.0000014 LB/GAL	150000	1	0.21
					FORMALDEHYDE	.0001 LB/GAL	150000	1	15
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	AMOCO/BRUCE-COOK INLET		CHROMIUM	.000007 LB/GAL	490000	1	3.4
					MANGANESE	.000004 LB/GAL	490000	1	2.0
					NICKEL	.00014 LB/GAL	490000	1	69
					PAH	.0000014 LB/GAL	490000	1	0.69
					FORMALDEHYDE	.0001 LB/GAL	490000	1	49

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	ARCO/KING SALMON-COOK INLET	CHROMIUM	.000007 LB/GAL	170000	1	1.2
				MANGANESE	.000004 LB/GAL	170000	1	0.68
				NICKEL	.00014 LB/GAL	170000	1	24
				PAH	.0000014 LB/GAL	170000	1	0.24
				FORMALDEHYDE	.0001 LB/GAL	170000	1	17
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	ATLANTIC RICHFIELD CO-KENAI PENINSULA	CHROMIUM	.000007 LB/GAL	CONF	1	
				MANGANESE	.000004 LB/GAL	CONF	1	
				NICKEL	.00014 LB/GAL	CONF	1	
				PAH	.0000014 LB/GAL	CONF	1	
				FORMALDEHYDE	.0001 LB/GAL	CONF	1	
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	SHELL/C-COOK INLET	CHROMIUM	.000007 LB/GAL	510000	1	3.6
				MANGANESE	.000004 LB/GAL	510000	1	2.0
				NICKEL	.00014 LB/GAL	510000	1	71
				PAH	.0000014 LB/GAL	510000	1	0.71
				FORMALDEHYDE	.0001 LB/GAL	510000	1	51
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	UNOCAL/GRANITE POINT-COOK INLET	CHROMIUM	.000007 LB/GAL	100000	1	0.70
				MANGANESE	.000004 LB/GAL	100000	1	0.40
				NICKEL	.00014 LB/GAL	100000	1	14
				PAH	.0000014 LB/GAL	100000	1	0.14
				FORMALDEHYDE	.0001 LB/GAL	100000	1	10
1311	CRUDE OIL AND GAS PRODUCTION	RECIPROCATING DIESEL ENG	UNOCAL/GRAYLING-COOK INLET	CHROMIUM	.000007 LB/GAL	510000	1	3.6
				MANGANESE	.000004 LB/GAL	510000	1	2.0
				NICKEL	.00014 LB/GAL	510000	1	71
				PAH	.0000014 LB/GAL	510000	1	0.71
				FORMALDEHYDE	.0001 LB/GAL	510000	1	51

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
1311	CRUDE OIL AND GAS PRODUCTION	WOOD COMBUSTION	ATLANTIC RICHFIELD CO-BARROW	ALDEHYDES	UNKNOWN		1000	1	
				PAH	.16	LB/TON WOOD	1000	1	160
1629	HEAVY CONSTRUCTION	RECIPROCATING DIESEL ENG	STANDARD ALASKA PRODUCTION CO-BARROW	CHROMIUM	.000007	LB/GAL	287000	1	2.0
				MANGANESE	.000004	LB/GAL	287000	1	1.1
				NICKEL	.00014	LB/GAL	287000	1	40
				PAH	.0000014	LB/GAL	287000	1	0.40
				FORMALDEHYDE	.0001	LB/GAL	287000	1	29
2077	ANIMAL\MARINE FATS\OILS	WASTE OIL COMBUSTION	CITY OF KODIAK FISH PROCESSING PLNT-	ARSENIC	.000042	LB/GAL	N/A	1	
				CADMIUM	.000017	LB/GAL	N/A	1	
				CHROMIUM	.000083	LB/GAL	N/A	1	
				LEAD	.00083	LB/GAL	N/A	1	
				MANGANESE	UNKNOWN		N/A	1	
				NICKEL	UNKNOWN		N/A	1	
				PAH	1.0E-07	LB/GAL	N/A	1	
				FORMALDEHYDE	.000033	LB/GAL	N/A	1	
2077	ANIMAL\MARINE FATS\OILS	WASTE OIL COMBUSTION	GREAT LANDS SEAFOOD-UNALASKA	ARSENIC	.000042	LB/GAL	N/A	1	
				CADMIUM	.000017	LB/GAL	N/A	1	
				CHROMIUM	.000083	LB/GAL	N/A	1	
				LEAD	.00083	LB/GAL	N/A	1	
				MANGANESE	UNKNOWN		N/A	1	
				NICKEL	UNKNOWN		N/A	1	
				PAH	1.0E-07	LB/GAL	N/A	1	
				FORMALDEHYDE	.000033	LB/GAL	N/A	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2077	ANIMAL\MARINE FATS\OILS	WASTE OIL COMBUSTION	ICICLE SEAFOODS-SEWARD	ARSENIC	.000042	LB/GAL	150000	1	6.3
				CADMIUM	.000017	LB/GAL	150000	1	2.5
				CHROMIUM	.000083	LB/GAL	150000	1	12
				LEAD	.00083	LB/GAL	150000	1	120
				MANGANESE	UNKNOWN		150000	1	
				NICKEL	UNKNOWN		150000	1	
				PAH	1.8E-07	LB/GAL	150000	1	<0.1
				FORMALDEHYDE	.000033	LB/GAL	150000	1	5.0
2421	SAW MILLS	RECIPROCATING DIESEL ENG	WRANGELL FOREST PRODUCTS-WRANGELL	CHROMIUM	.000007	LB/GAL	125000	1	0.88
				MANGANESE	.000004	LB/GAL	125000	1	0.50
				NICKEL	.00014	LB/GAL	125000	1	18
				PAH	.0000014	LB/GAL	125000	1	0.17
				FORMALDEHYDE	.0001	LB/GAL	125000	1	12
2421	SAW MILLS	WOOD COMBUSTION	MITKOF LUMBER CO-WRANGELL	ALDEHYDES	UNKNOWN		2245	1	
				PAH	.16	LB/TON WOOD	2245	1	360
2421	SAW MILLS	WOOD COMBUSTION	PACIFIC FORESET PRODUCTS-HAINES	ALDEHYDES	UNKNOWN		1710	1	
				PAH	.16	LB/TON WOOD	1710	1	270
2421	SAW MILLS	WOOD COMBUSTION	WRANGELL FOREST PRODUCTS-WRANGELL	ALDEHYDES	UNKNOWN		35000	1	
				PAH	.16	LB/TON WOOD	35000	1	5600
2611	PULP MILLS	DISTILLATE OIL COMBUSTION	ALASKA PULP CORP-SITKA	CHROMIUM	.000007	LB/GAL	12221000	.2	17
				FORMALDEHYDE	.000033	LB/GAL	12221000	1	400
				MANGANESE	.000004	LB/GAL	12221000	.2	9.8
				NICKEL	.00014	LB/GAL	12221000	.2	340
				PAH	1.8E-07	LB/GAL	12221000	1	2.2
				RADIONUCLIDES	UNKNOWN		12221000	.2	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2611	PULP MILLS	WOOD COMBUSTION	ALASKA PULP CORP-SITKA	ALDEHYDES	UNKNOWN	42000	1	
				PAH	.16 LB/TON WOOD	42000	1	6700
2611	PULP MILLS	WOOD COMBUSTION	KETCHIKAN PULPCO-KETCHIKAN	ALDEHYDES	UNKNOWN	105000	1	
				PAH	.16 LB/TON WOOD	105000	1	17000
2611	PULP MILLS	WASTE WATER EMISSIONS	ALASKA PULP CORP-SITKA	CHLOROFORM	.146 LB/AIR DRIED TON	230000	1	34000
2611	PULP MILLS	WASTE WATER EMISSIONS	KETCHIKAN PULPCO-KETCHIKAN	CHLOROFORM	.146 LB/AIR DRIED TON	202000	1	29000
2851	PAINT AND ALLIED PRODUCTS	PAINT MANUFACTURING	ALASKAN PAINT MANUFACTURING CO. INC-ANCHORAGE	TOLUENE	UNKNOWN SURVEY DATA	N/A	1	80
2873	NITROGENOUS FERTILIZERS	COOLING TOWERS	UNOCAL CHEMICAL DIVISION-KENAI PENINSULA	CHROMIUM	UNKNOWN	N/A	1	
				NICKEL	UNKNOWN	N/A	1	
				CHLOROFORM	1 LB/LB EMITTED	N/A	1	26000
2873	NITROGENOUS FERTILIZERS	WASTE OIL COMBUSTION	UNOCAL CHEMICAL DIVISION-KENAI PENINSULA	ARSENIC	.000042 LB/GAL	125000	1	13.0
					UNKNOWN SEE TEXT	125000	1	
				CADMIUM	.000017 LB/GAL	125000	1	2.1
				CHROMIUM	.000083 LB/GAL	125000	1	10
				LEAD	.00083 LB/GAL	125000	1	100
				MANGANESE	UNKNOWN	125000	1	
				NICKEL	UNKNOWN	125000	1	
				PAH	.000175 LB/GAL	125000	1	22
				FORMALDEHYDE	.033 LB/GAL	125000	1	4100
2911	PETROLEUM REFINING	COOLING TOWERS	PHILLIPS PETROLEUM-KENAI	CHROMIUM	UNKNOWN	N/A	1	
				NICKEL	UNKNOWN	N/A	1	
				CHLOROFORM	1 LB/LB EMITTED	N/A	1	2900
2911	PETROLEUM REFINING	COOLING TOWERS	TESORO-ALASKAN-KENAI PENINSULA	CHROMIUM	UNKNOWN	N/A	1	
				NICKEL	UNKNOWN	N/A	1	
				CHLOROFORM	1 LB/LB EMITTED	N/A	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2911	PETROLEUM REFINING	GASOLINE EVAPORATION	TESORO-ALASKAN-KENAI PENINSULA	BENZENE	20	LB/TON THC	3120	1	63000
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	3120	1	5.0
				ETHYLENE DICHLORIDE	.011	LB/TON THC	3120	1	34
2911	PETROLEUM REFINING	COMPLEX REFINERY FUGITIVES	TESORO PETROLEUM CORP-KENAI PENINSULA	BENZENE	7.2	LB/TON THC	751	1	5400
				TOLUENE	21	LB/TON THC	751	1	16000
				XYLENE	31	LB/TON THC	751	1	23000
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	ARCO-KUPARUK	BENZENE	.72	LB/TON THC	160	1	120
				TOLUENE	2.1	LB/TON THC	160	1	340
				XYLENE	3.1	LB/TON THC	160	1	500
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	ARCO-PRUDHOE BAY	BENZENE	.72	LB/TON THC	160	1	120
				TOLUENE	2.1	LB/TON THC	160	1	340
				XYLENE	3.1	LB/TON THC	160	1	500
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	ARCTIC ENERGY-FOX	BENZENE	.72	LB/TON THC	350	1	250
				TOLUENE	2.1	LB/TON THC	350	1	740
				XYLENE	3.1	LB/TON THC	350	1	1100
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	CHEVRON USA-KENAI PENINSULA	BENZENE	.72	LB/TON THC	175	1	130
				TOLUENE	2.1	LB/TON THC	175	1	370
				XYLENE	3.1	LB/TON THC	175	1	540
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	MAPCO PETROLEUM CORP-NORTH POLE	BENZENE	.72	LB/TON THC	400	1	290
				TOLUENE	2.1	LB/TON THC	400	1	840
				XYLENE	3.1	LB/TON THC	400	1	1200
2911	PETROLEUM REFINING	TOPPING REFINERY FUGITIVES	PETRO STAR INC.-NORTH POLE	BENZENE	.72	LB/TON THC	160	1	120
				TOLUENE	2.1	LB/TON THC	160	1	340
				XYLENE	3.1	LB/TON THC	160	1	500

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2911	PETROLEUM REFINING	RECIPROCATING DIESEL ENG	MAPCO PETROLEUM CORP-NORTH POLE	CHROMIUM	.000007	LB/GAL	434000	1	3.0
				MANGANESE	.000004	LB/GAL	434000	1	1.7
				NICKEL	.00014	LB/GAL	434000	1	61
				PAH	.0000014	LB/GAL	434000	1	0.61
				FORMALDEHYDE	.0001	LB/GAL	434000	1	43
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ANCHORAGE SAND & GRAVEL-ANCHORAGE	BENZENE	.0027	LB/TON PROD	204000	1	550
				FORMALDEHYDE	.00015	LB/TON PROD	204000	1	31
				PAH	.000026	LB/TON PROD	204000	1	5.3
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ASSOCIATED ASPHALT PAVING-ANCHORAGE	BENZENE	.0027	LB/TON PROD	51000	1	140
				FORMALDEHYDE	.00015	LB/TON PROD	51000	1	7.7
				PAH	.000026	LB/TON PROD	51000	1	1.3
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ASSOCIATED SAND & GRAVEL #3-KETCHIKAN	BENZENE	.0027	LB/TON PROD	10507	1	28
				FORMALDEHYDE	.00015	LB/TON PROD	10507	1	1.6
				PAH	.000026	LB/TON PROD	10507	1	0.27
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ASSOCIATED SAND & GRAVEL #14-PTBURG,KETCH,SITKA	BENZENE	.0027	LB/TON PROD	75269	1	200
				FORMALDEHYDE	.00015	LB/TON PROD	75269	1	11
				PAH	.000026	LB/TON PROD	75269	1	2.0
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ASSOCIATED SAND & GRAVEL #15-JUNEAU	BENZENE	.0027	LB/TON PROD	19686	1	53
				FORMALDEHYDE	.00015	LB/TON PROD	19686	1	3.0
				PAH	.000026	LB/TON PROD	19686	1	0.51
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	BRECHAN ENTERPRISE-KODIAK	BENZENE	.0027	LB/TON PROD	8400	1	23
				FORMALDEHYDE	.00015	LB/TON PROD	8400	1	1.3
				PAH	.000026	LB/TON PROD	8400	1	0.22

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	BRIDGEWATER-FAIRBANKS	BENZENE	.0027	LB/TON PROD	21704	1	59
				FORMALDEHYDE	.00015	LB/TON PROD	21704	1	3.3
				PAH	.000026	LB/TON PROD	21704	1	0.56
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	CENTRAL PAVING/RED SAMM-ANCHORAGE	BENZENE	.0027	LB/TON PROD	28000	1	76
				FORMALDEHYDE	.00015	LB/TON PROD	28000	1	4.2
				PAH	.000026	LB/TON PROD	28000	1	0.73
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	EARTHMOVERS OF FAIRBANKS-ANCHORAGE	BENZENE	.0027	LB/TON PROD	24741	1	67
				FORMALDEHYDE	.00015	LB/TON PROD	24741	1	3.7
				PAH	.000026	LB/TON PROD	24741	1	0.64
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	EARTHMOVERS OF FAIRBANKS-FAIRBANKS	BENZENE	.0027	LB/TON PROD	5679	1	15
				FORMALDEHYDE	.00015	LB/TON PROD	5679	1	0.85
				PAH	.000026	LB/TON PROD	5679	1	0.15
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	EARTHMOVERS OF FAIRBANKS-FAIRBANKS	BENZENE	.0027	LB/TON PROD	23018	1	62
				FORMALDEHYDE	.00015	LB/TON PROD	23018	1	3.5
				PAH	.000026	LB/TON PROD	23018	1	0.60
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	HARLEY'S TRUCKING-SOLDOTINA	BENZENE	.0027	LB/TON PROD	95108	1	260
				FORMALDEHYDE	.00015	LB/TON PROD	95108	1	14
				PAH	.000026	LB/TON PROD	95108	1	2.5
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	KNIK CONSTRUCTION-LYNDEN	BENZENE	.0027	LB/TON PROD	11438	1	31
				FORMALDEHYDE	.00015	LB/TON PROD	11438	1	1.7
				PAH	.000026	LB/TON PROD	11438	1	0.30
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	M-B CONTRACTING CO-ANCHORAGE	BENZENE	.0027	LB/TON PROD	58224	1	160
				FORMALDEHYDE	.00015	LB/TON PROD	58224	1	8.7
				PAH	.000026	LB/TON PROD	58224	1	1.5

NOTES: N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	PARKER PAVING CORP-ANCHORAGE	BENZENE	.0027	LB/TON PROD	N/A	1	
				FORMALDEHYDE	.00015	LB/TON PROD	N/A	1	
				PAH	.000026	LB/TON PROD	N/A	1	
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	PAVING PRODUCTS-FAIRBANKS	BENZENE	.0027	LB/TON PROD	34051	1	92
				FORMALDEHYDE	.00015	LB/TON PROD	34051	1	5.2
				PAH	.000026	LB/TON PROD	34051	1	0.91
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	QUALITY ASPHALT PAVING-ANCHORAGE	BENZENE	.0027	LB/TON PROD	52000	1	140
				FORMALDEHYDE	.00015	LB/TON PROD	52000	1	7.8
				PAH	.000026	LB/TON PROD	52000	1	1.4
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	RASCO INC-FAIRBANKS	BENZENE	.0027	LB/TON PROD	22167	1	60
				FORMALDEHYDE	.00015	LB/TON PROD	22167	1	3.3
				PAH	.000026	LB/TON PROD	22167	1	0.58
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	RASMUSSEN'S CO-ANCHORAGE	BENZENE	.0027	LB/TON PROD	500	1	1.4
				FORMALDEHYDE	.00015	LB/TON PROD	500	1	<0.1
				PAH	.000026	LB/TON PROD	500	1	<0.1
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	RED SAMM-JUNEAU	BENZENE	.0027	LB/TON PROD	N/A	1	
				FORMALDEHYDE	.00015	LB/TON PROD	N/A	1	
				PAH	.000026	LB/TON PROD	N/A	1	
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-ANCHORAGE	BENZENE	.0027	LB/TON PROD	12482	1	34
				FORMALDEHYDE	.00015	LB/TON PROD	12482	1	1.9
				PAH	.000026	LB/TON PROD	12482	1	0.32
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-ANCHORAGE	BENZENE	.0027	LB/TON PROD	3260	1	8.8
				FORMALDEHYDE	.00015	LB/TON PROD	3260	1	0.49
				PAH	.000026	LB/TON PROD	3260	1	<0.1

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-ANCHORAGE	BENZENE	.0027	LB/TON PROD	31717	1	86
				FORMALDEHYDE	.00015	LB/TON PROD	31717	1	4.8
				PAH	.000026	LB/TON PROD	31717	1	0.82
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-ANCHORAGE	BENZENE	.0027	LB/TON PROD	203353	1	550
				FORMALDEHYDE	.00015	LB/TON PROD	203353	1	31
				PAH	.000026	LB/TON PROD	203353	1	5.3
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-ANCHORAGE	BENZENE	.0027	LB/TON PROD	81000	1	220
				FORMALDEHYDE	.00015	LB/TON PROD	81000	1	12
				PAH	.000026	LB/TON PROD	81000	1	2.1
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	ROGERS & BABLER-FAIRBANKS	BENZENE	.0027	LB/TON PROD	92700	1	250
				FORMALDEHYDE	.00015	LB/TON PROD	92700	1	14
				PAH	.000026	LB/TON PROD	92700	1	2.4
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	TRANS-ALASKA CONSTRUCTION-EAGLE RIVER	BENZENE	.0027	LB/TON PROD	2255	1	6.1
				FORMALDEHYDE	.00015	LB/TON PROD	2255	1	0.34
				PAH	.000026	LB/TON PROD	2255	1	<0.1
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	TRANS-ALASKA CONSTRUCTION-FAIRBANKS	BENZENE	.0027	LB/TON PROD	44381	1	120
				FORMALDEHYDE	.00015	LB/TON PROD	44381	1	6.7
				PAH	.000026	LB/TON PROD	44381	1	1.2
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	VALLEY ASPHALT CO-PALMER	BENZENE	.0027	LB/TON PROD	19987	1	54
				FORMALDEHYDE	.00015	LB/TON PROD	19987	1	3.0
				PAH	.000026	LB/TON PROD	19987	1	0.52
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	KEL-ASKA CORP-VALDEZ	BENZENE	.0027	LB/TON PROD	N/A	1	
				FORMALDEHYDE	.00015	LB/TON PROD	N/A	1	
				PAH	.000026	LB/TON PROD	N/A	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	WILDER CONSTRUCTION-ANCHORAGE	BENZENE	.0027	LB/TON PROD	15000	1	40
				FORMALDEHYDE	.00015	LB/TON PROD	15000	1	2.2
				PAH	.000026	LB/TON PROD	15000	1	0.39
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	WILDER CONSTRUCTION CO-ANCHORAGE	BENZENE	.0027	LB/TON PROD	90000	1	240
				FORMALDEHYDE	.00015	LB/TON PROD	90000	1	14
				PAH	.000026	LB/TON PROD	90000	1	2.3
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	WILDER CONSTRUCTION CO-ANCHORAGE	BENZENE	.0027	LB/TON PROD	103600	1	280
				FORMALDEHYDE	.00015	LB/TON PROD	103600	1	16
				PAH	.000026	LB/TON PROD	103600	1	2.7
2951	PAVING MIXTURES AND BLOCKS	HOT MIX ASPHALT PRODUCTION	WILSON CONSTRUCTION-CORDOVA	BENZENE	.0027	LB/TON PROD	N/A	1	
				FORMALDEHYDE	.00015	LB/TON PROD	N/A	1	
				PAH	.000026	LB/TON PROD	N/A	1	
3241	CEMENT MANUFACTURE	CEMENT GRINDER-WET PROCESS	ALASKA BASIC INDUSTRIES-ANCHORAGE	CHROMIUM	.0034	LB/TON PROD	34686	.002	0.24
				NICKEL	.002	LB/TON PROD	34686	.002	0.14
3273	READY MIXED CONCRETE	RECIPROCATING DIESEL ENG	PAVING PRODUCTS INC-FAIRBANKS	CHROMIUM	.000007	LB/GAL	200000	.03	<0.1
				MANGANESE	.000004	LB/GAL	200000	.03	<0.1
				NICKEL	.00014	LB/GAL	200000	.03	0.84
				PAH	.0000014	LB/GAL	200000	1	0.28
				FORMALDEHYDE	.0001	LB/GAL	200000	.03	0.60
3471	PLATING & POLISHING	ELECTROPLATING-CHROMIUM	AA MECHANICAL-ANCHORAGE	CHROMIUM	.0000075	LB/HR:AMP	N/A	1	
3471	PLATING & POLISHING	ELECTROPLATING-CHROMIUM	ENGINE GEER CO., INC-ANCHORAGE	CHROMIUM	.0000075	LB/HR:AMP	210000	1	1.6
3471	PLATING & POLISHING	ELECTROPLATING-CHROMIUM	SHOVELHEAD HYDRAULICS-FAIRBANKS	CHROMIUM	.0000075	LB/HR:AMP	N/A	1	
3471	PLATING & POLISHING	CHROME PLATING-DECORATIVE	ALASKA ELECTROPLATING & BUMPER REP.-ANCHORAGE	CHROMIUM	.0000075	LB/HR:AMP	762000	1	5.7

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
3691	BATTERY MANUFACTURING	BATTERY MANUFACTURING	ALASKA HUSKY BATTERY INC-ANCHORAGE	LEAD	1 LB/LB EMITTED	130	1	130
				ARSENIC	UNKNOWN	130	1	
				CADMIUM	UNKNOWN	130	1	
				MANGANESE	UNKNOWN	130	1	
4463	MARINE CARGO HANDLING	RESIDUAL OIL COMBUSTION	COOK INLET PIPELINE-KENAI PENINSULA	CHROMIUM	.000007 LB/GAL	275000	1	1.9
				FORMALDEHYDE	.000033 LB/GAL	275000	1	9.1
				MANGANESE	.000004 LB/GAL	275000	1	1.1
				NICKEL	.00014 LB/GAL	275000	1	38
				PAH	1.8E-07 LB/GAL	275000	1	<0.1
				RADIONUCLIDES	UNKNOWN	275000	1	
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	ANCHORAGE INTERNATIONAL-ANCHORAGE	PAH	UNKNOWN	317	1	
				DIOXINS	UNKNOWN	317	1	
				FORMALDEHYDE	UNKNOWN	317	1	
				XYLENE	282 LB/TON THC	317	1	89000
				BENZENE	13.4 LB/TON THC	317	1	4200
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	DEAD HORSE AIRPORT-DEADHORSE	PAH	UNKNOWN	15	1	
				DIOXINS	UNKNOWN	15	1	
				FORMALDEHYDE	UNKNOWN	15	1	
				XYLENE	282 LB/TON THC	15	1	4300
				BENZENE	13.4 LB/TON THC	15	1	210
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	FAIRBANKS INTERNATIONAL-FAIRBANKS	PAH	UNKNOWN	59	1	
				DIOXINS	UNKNOWN	59	1	
				FORMALDEHYDE	UNKNOWN	59	1	
				XYLENE	282 LB/TON THC	59	1	17000
				BENZENE	13.4 LB/TON THC	59	1	790

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	JUNEAU AIRPORT-JUNEAU	PAH	UNKNOWN		22	1	
				DIOXINS	UNKNOWN		22	1	
				FORMALDEHYDE	UNKNOWN		22	1	
				XYLENE	282	LB/TON THC	22	1	6100
				BENZENE	13.4	LB/TON THC	22	1	290
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	KETCHIKAN INTERNATIONAL-KETCHIKAN	PAH	UNKNOWN		15	1	
				DIOXINS	UNKNOWN		15	1	
				FORMALDEHYDE	UNKNOWN		15	1	
				XYLENE	282	LB/TON THC	15	1	4200
				BENZENE	13.4	LB/TON THC	15	1	200
4582	AIRPORTS & AIRCRAFT MAINTENANCE	AIRPORTS	SITKA AIRPORT-SITKA	PAH	UNKNOWN		10	1	
				DIOXINS	UNKNOWN		10	1	
				FORMALDEHYDE	UNKNOWN		10	1	
				XYLENE	282	LB/TON THC	10	1	2700
				BENZENE	13.4	LB/TON THC	10	1	130
4612	CRUDE PETROLEUM PIPE LINES	DISTILLATE OIL COMBUSTION	ALYESKA PIPELINE PUMP STATION 011-COPPER CENTER	CHROMIUM	.000007	LB/GAL	133800	1	0.94
				FORMALDEHYDE	.000033	LB/GAL	133800	1	4.4
				MANGANESE	.000004	LB/GAL	133800	1	0.54
				NICKEL	.00014	LB/GAL	133800	1	19
				PAH	1.0E-07	LB/GAL	133800	1	<0.1
				RADIONUCLIDES	UNKNOWN		133800	1	
4612	CRUDE PETROLEUM PIPE LINES	DISTILLATE OIL COMBUSTION	ALYESKA PIPELINE PUMP STATION 07-LIVENGOOD	CHROMIUM	.000007	LB/GAL	73000	1	0.51
				FORMALDEHYDE	.000033	LB/GAL	73000	1	2.4
				MANGANESE	.000004	LB/GAL	73000	1	0.29
				NICKEL	.00014	LB/GAL	73000	1	10
				PAH	1.0E-07	LB/GAL	73000	1	<0.1
				RADIONUCLIDES	UNKNOWN		73000	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4612	CRUDE PETROLEUM PIPE LINES	DISTILLATE OIL COMBUSTION	ALYESKA PIPELINE PUMP STATION 08-FAIRBANKS	CHROMIUM	.000007 LB/GAL	54000	1	0.38
				FORMALDEHYDE	.000033 LB/GAL	54000	1	1.8
				MANGANESE	.000004 LB/GAL	54000	1	0.22
				NICKEL	.00014 LB/GAL	54000	1	7.6
				PAH	1.0E-07 LB/GAL	54000	1	<0.1
				RADIONUCLIDES	UNKNOWN	54000	1	
4612	CRUDE PETROLEUM PIPE LINES	MUNICIPAL INCINERATION-SC	ALYESKA PIPELINE/PUMP STATION 03-SAGAVANIRTOK	ARSENIC	.0018 LB/TON	300	1	0.54
				BERYLLIUM	.000045 LB/TON	300	1	<0.1
				CADMIUM	.012 LB/TON	300	1	3.6
				CHROMIUM	.074 LB/TON	300	1	22
				LEAD	.29 LB/TON	300	1	87
				MANGANESE	.027 LB/TON	300	1	8.1
				NICKEL	.062 LB/TON	300	1	19
				PAH	.00012 LB/TON	300	1	<0.1
				FURANS	.000003 LB/TON	300	1	<0.1
				PCB	.000002 LB/TON	300	1	<0.1
				DIOXINS	.0000002 LB/TON	300	1	<0.1
4612	CRUDE PETROLEUM PIPE LINES	TOPPING REFINERY FUGITIVES	ALYESKA PIPELINE/PUMP STATION 010-BLACK RAPIDS	BENZENE	.72 LB/TON THC	350	1	250
				TOLUENE	2.1 LB/TON THC	350	1	740
				XYLENE	3.1 LB/TON THC	350	1	1100
4612	CRUDE PETROLEUM PIPE LINES	TOPPING REFINERY FUGITIVES	ALYESKA PIPELINE/PUMP STATION 08-FAIRBANKS	BENZENE	.72 LB/TON THC	350	1	250
				TOLUENE	2.1 LB/TON THC	350	1	740
				XYLENE	3.1 LB/TON THC	350	1	1100

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA MARINE TERMINAL-VALDEZ	CHROMIUM	.000007	LB/GAL	4600000	1	32
				MANGANESE	.000004	LB/GAL	4600000	1	18
				NICKEL	.00014	LB/GAL	4600000	1	640
				PAH	.0000002	LB/GAL	4600000	1	0.92
				FORMALDEHYDE	.00015	LB/GAL	4600000	1	690
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION #10-BLACK RAPIDS	CHROMIUM	.000007	LB/GAL	24226000	1	170
				MANGANESE	.000004	LB/GAL	24226000	1	97
				NICKEL	.00014	LB/GAL	24226000	1	3400
				PAH	.0000002	LB/GAL	24226000	1	4.8
				FORMALDEHYDE	.00015	LB/GAL	24226000	1	3600
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION #11-COPPER CENTER	CHROMIUM	.000007	LB/GAL	25266810	1	180
				MANGANESE	.000004	LB/GAL	25266810	1	100
				NICKEL	.00014	LB/GAL	25266810	1	3500
				PAH	.0000002	LB/GAL	25266810	1	5.1
				FORMALDEHYDE	.00015	LB/GAL	25266810	1	3800
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION #5-PROSPECT	CHROMIUM	.000007	LB/GAL	11520000	1	81
				MANGANESE	.000004	LB/GAL	11520000	1	46
				NICKEL	.00014	LB/GAL	11520000	1	1600
				PAH	.0000002	LB/GAL	11520000	1	2.3
				FORMALDEHYDE	.00015	LB/GAL	11520000	1	1700
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION #6-YUKON RIVER	CHROMIUM	.000007	LB/GAL	20660000	1	140
				MANGANESE	.000004	LB/GAL	20660000	1	83
				NICKEL	.00014	LB/GAL	20660000	1	2900
				PAH	.0000002	LB/GAL	20660000	1	4.1
				FORMALDEHYDE	.00015	LB/GAL	20660000	1	3100

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION 07-LIVENGOOD	CHROMIUM	.000007 LB/GAL	23000000	1	160
				MANGANESE	.000004 LB/GAL	23000000	1	92
				NICKEL	.00014 LB/GAL	23000000	1	3200
				PAH	.0000002 LB/GAL	23000000	1	4.6
				FORMALDEHYDE	.00015 LB/GAL	23000000	1	3400
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION 08-FAIRBANKS	CHROMIUM	.000007 LB/GAL	22750000	1	160
				MANGANESE	.000004 LB/GAL	22750000	1	91
				NICKEL	.00014 LB/GAL	22750000	1	3200
				PAH	.0000002 LB/GAL	22750000	1	4.5
				FORMALDEHYDE	.00015 LB/GAL	22750000	1	3400
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA PIPELINE PUMP STATION 09-DELTA	CHROMIUM	.000007 LB/GAL	20674000	1	140
				MANGANESE	.000004 LB/GAL	20674000	1	83
				NICKEL	.00014 LB/GAL	20674000	1	2900
				PAH	.0000002 LB/GAL	20674000	1	4.1
				FORMALDEHYDE	.00015 LB/GAL	20674000	1	3100
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA/PUMP STATION 01-DEADHORSE	CHROMIUM	.000007 LB/GAL	114000	1	0.80
				MANGANESE	.000004 LB/GAL	114000	1	0.46
				NICKEL	.00014 LB/GAL	114000	1	16
				PAH	.0000002 LB/GAL	114000	1	<0.1
				FORMALDEHYDE	.00015 LB/GAL	114000	1	17
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA/PUMP STATION 02-SAGWON	CHROMIUM	.000007 LB/GAL	50000	1	0.35
				MANGANESE	.000004 LB/GAL	50000	1	0.20
				NICKEL	.00014 LB/GAL	50000	1	7.0
				PAH	.0000002 LB/GAL	50000	1	<0.1
				FORMALDEHYDE	.00015 LB/GAL	50000	1	7.5

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4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA/PUMP STATION 03-SAGAVANIRTOK	CHROMIUM	.000007	LB/GAL	267172	1	1.9
				MANGANESE	.000004	LB/GAL	267172	1	1.1
				NICKEL	.00014	LB/GAL	267172	1	37
				PAH	.0000002	LB/GAL	267172	1	<0.1
				FORMALDEHYDE	.00015	LB/GAL	267172	1	40
4612	CRUDE PETROLEUM PIPE LINES	TURBINE DIESEL ENG	ALYESKA/PUMP STATION 04-ATIGUN RIVER	CHROMIUM	.000007	LB/GAL	50000	1	0.35
				MANGANESE	.000004	LB/GAL	50000	1	0.20
				NICKEL	.00014	LB/GAL	50000	1	7.0
				PAH	.0000002	LB/GAL	50000	1	<0.1
				FORMALDEHYDE	.00015	LB/GAL	50000	1	7.5
4911	ELECTRICITY PRODUCTION	COAL COMBUSTION	GOLDEN VALLEY E ASSN-HEALY	ARSENIC	.028	LB/TON	160000	.025	110
				BERYLLIUM	.00083	LB/TON	160000	.025	3.3
				CADMIUM	.0083	LB/TON	160000	.025	33
				CHROMIUM	.024	LB/TON	160000	.025	96
				RADIONUCLIDES	.0027	LB/TON	160000	1	430
				FORMALDEHYDE	.0032	LB/TON	160000	1	510
				MANGANESE	.077	LB/TON	160000	.025	310
				MERCURY	.00038	LB/TON	160000	.025	1.5
				NICKEL	.024	LB/TON	160000	.025	96
				PAH	.000024	LB/TON	160000	1	3.8
4911	ELECARICITY PRODUCTION	COOLING TOWERS	ANCHORAGE LIGHT AND POWER-ANCHORAGE	CHROMIUM	UNKNOWN		N/A	1	
				NICKEL	UNKNOWN		N/A	1	
				CHLOROFORM	1	LB/LB EMITTED	N/A	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-AMBLER	CHROMIUM	.000007	LB/GAL	274200	1	1.9
				MANGANESE	.000004	LB/GAL	274200	1	1.1
				NICKEL	.00014	LB/GAL	274200	1	38
				PAH	.0000014	LB/GAL	274200	1	0.38
				FORMALDEHYDE	.0001	LB/GAL	274200	1	27
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-EEK	CHROMIUM	.000007	LB/GAL	271600	1	1.9
				MANGANESE	.000004	LB/GAL	271600	1	1.1
				NICKEL	.00014	LB/GAL	271600	1	38
				PAH	.0000014	LB/GAL	271600	1	0.38
				FORMALDEHYDE	.0001	LB/GAL	271600	1	27
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-ELIM	CHROMIUM	.000007	LB/GAL	224300	1	1.6
				MANGANESE	.000004	LB/GAL	224300	1	0.90
				NICKEL	.00014	LB/GAL	224300	1	31
				PAH	.0000014	LB/GAL	224300	1	0.31
				FORMALDEHYDE	.0001	LB/GAL	224300	1	22
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-FORTUNA LEDGE	CHROMIUM	.000007	LB/GAL	272400	1	1.9
				MANGANESE	.000004	LB/GAL	272400	1	1.1
				NICKEL	.00014	LB/GAL	272400	1	38
				PAH	.0000014	LB/GAL	272400	1	0.38
				FORMALDEHYDE	.0001	LB/GAL	272400	1	27
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-GAMBELL	CHROMIUM	.000007	LB/GAL	466900	1	3.3
				MANGANESE	.000004	LB/GAL	466900	1	1.9
				NICKEL	.00014	LB/GAL	466900	1	65
				PAH	.0000014	LB/GAL	466900	1	0.65
				FORMALDEHYDE	.0001	LB/GAL	466900	1	47

NOTES: N/A - NOT AVAILABLE
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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTION	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-GOODNEWS BAY	CHROMIUM	.000007	LB/GAL	233000	1	1.6
				MANGANESE	.000004	LB/GAL	233000	1	0.93
				NICKEL	.00014	LB/GAL	233000	1	33
				PAH	.0000014	LB/GAL	233000	1	0.33
				FORMALDEHYDE	.0001	LB/GAL	233000	1	23
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-GRAYLING	CHROMIUM	.000007	LB/GAL	233000	1	1.6
				MANGANESE	.000004	LB/GAL	233000	1	0.93
				NICKEL	.00014	LB/GAL	233000	1	33
				PAH	.0000014	LB/GAL	233000	1	0.33
				FORMALDEHYDE	.0001	LB/GAL	233000	1	23
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-HOLY CROSS	CHROMIUM	.000007	LB/GAL	252300	1	1.8
				MANGANESE	.000004	LB/GAL	252300	1	1.0
				NICKEL	.00014	LB/GAL	252300	1	35
				PAH	.0000014	LB/GAL	252300	1	0.35
				FORMALDEHYDE	.0001	LB/GAL	252300	1	25
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-KATAG	CHROMIUM	.000007	LB/GAL	240900	1	1.7
				MANGANESE	.000004	LB/GAL	240900	1	0.96
				NICKEL	.00014	LB/GAL	240900	1	34
				PAH	.0000014	LB/GAL	240900	1	0.34
				FORMALDEHYDE	.0001	LB/GAL	240900	1	24
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-KIANA	CHROMIUM	.000007	LB/GAL	516000	1	3.6
				MANGANESE	.000004	LB/GAL	516000	1	[illegible]
				NICKEL	.00014	LB/GAL	516000	1	72
				PAH	.0000014	LB/GAL	516000	1	0.72
				FORMALDEHYDE	.0001	LB/GAL	516000	1	52

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-KIVALINA	CHROMIUM	.000007 LB/GAL	293500	1	2.1
				MANGANESE	.000004 LB/GAL	293500	1	1.2
				NICKEL	.00014 LB/GAL	293500	1	41
				PAH	.0000014 LB/GAL	293500	1	0.41
				FORMALDEHYDE	.0001 LB/GAL	293500	1	29
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-KOYUK	CHROMIUM	.000007 LB/GAL	236500	1	1.7
				MANGANESE	.000004 LB/GAL	236500	1	0.95
				NICKEL	.00014 LB/GAL	236500	1	33
				PAH	.0000014 LB/GAL	236500	1	0.33
				FORMALDEHYDE	.0001 LB/GAL	236500	1	24
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-MINTO	CHROMIUM	.000007 LB/GAL	161200	1	1.1
				MANGANESE	.000004 LB/GAL	161200	1	0.64
				NICKEL	.00014 LB/GAL	161200	1	23
				PAH	.0000014 LB/GAL	161200	1	0.23
				FORMALDEHYDE	.0001 LB/GAL	161200	1	16
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-MT VILLAGE	CHROMIUM	.000007 LB/GAL	686800	1	4.8
				MANGANESE	.000004 LB/GAL	686800	1	2.7
				NICKEL	.00014 LB/GAL	686800	1	96
				PAH	.0000014 LB/GAL	686800	1	0.96
				FORMALDEHYDE	.0001 LB/GAL	686800	1	69
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-NEW STUYAHOK	CHROMIUM	.000007 LB/GAL	207612	1	1.5
				MANGANESE	.000004 LB/GAL	207612	1	0.83
				NICKEL	.00014 LB/GAL	207612	1	29
				PAH	.0000014 LB/GAL	207612	1	0.29
				FORMALDEHYDE	.0001 LB/GAL	207612	1	21

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-NOATAK	CHROMIUM	.000007	LB/GAL	436200	1	3.1
				MANGANESE	.000004	LB/GAL	436200	1	1.7
				NICKEL	.00014	LB/GAL	436200	1	61
				PAH	.0000014	LB/GAL	436200	1	0.61
				FORMALDEHYDE	.0001	LB/GAL	436200	1	44
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-NOORVIK	CHROMIUM	.000007	LB/GAL	519500	1	3.6
				MANGANESE	.000004	LB/GAL	519500	1	2.1
				NICKEL	.00014	LB/GAL	519500	1	73
				PAH	.0000014	LB/GAL	519500	1	0.73
				FORMALDEHYDE	.0001	LB/GAL	519500	1	52
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-NULATO	CHROMIUM	.000007	LB/GAL	394200	1	2.8
				MANGANESE	.000004	LB/GAL	394200	1	1.6
				NICKEL	.00014	LB/GAL	394200	1	55
				PAH	.0000014	LB/GAL	394200	1	0.55
				FORMALDEHYDE	.0001	LB/GAL	394200	1	39
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-NUNAPITCHUK	CHROMIUM	.000007	LB/GAL	523000	1	3.7
				MANGANESE	.000004	LB/GAL	523000	1	2.1
				NICKEL	.00014	LB/GAL	523000	1	73
				PAH	.0000014	LB/GAL	523000	1	0.73
				FORMALDEHYDE	.0001	LB/GAL	523000	1	52
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-OLD HARBOR	CHROMIUM	.000007	LB/GAL	248800	1	1.7
				MANGANESE	.000004	LB/GAL	248800	1	1.00
				NICKEL	.00014	LB/GAL	248800	1	35
				PAH	.0000014	LB/GAL	248800	1	0.35
				FORMALDEHYDE	.0001	LB/GAL	248800	1	25

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-SELAWIK	CHROMIUM	.000007	LB/GAL	539600	1	3.8
				MANGANESE	.000004	LB/GAL	539600	1	2.2
				NICKEL	.00014	LB/GAL	539600	1	76
				PAH	.0000014	LB/GAL	539600	1	0.76
				FORMALDEHYDE	.0001	LB/GAL	539600	1	54
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-SHAYELUK	CHROMIUM	.000007	LB/GAL	143700	1	1.0
				MANGANESE	.000004	LB/GAL	143700	1	0.57
				NICKEL	.00014	LB/GAL	143700	1	20
				PAH	.0000014	LB/GAL	143700	1	0.20
				FORMALDEHYDE	.0001	LB/GAL	143700	1	14
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-SHISHMAREF	CHROMIUM	.000007	LB/GAL	494900	1	3.5
				MANGANESE	.000004	LB/GAL	494900	1	2.0
				NICKEL	.00014	LB/GAL	494900	1	69
				PAH	.0000014	LB/GAL	494900	1	0.69
				FORMALDEHYDE	.0001	LB/GAL	494900	1	49
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-SHUNGNAK	CHROMIUM	.000007	LB/GAL	392400	1	2.7
				MANGANESE	.000004	LB/GAL	392400	1	1.6
				NICKEL	.00014	LB/GAL	392400	1	55
				PAH	.0000014	LB/GAL	392400	1	0.55
				FORMALDEHYDE	.0001	LB/GAL	392400	1	39
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-STEBBINS	CHROMIUM	.000007	LB/GAL	278600	1	2.0
				MANGANESE	.000004	LB/GAL	278600	1	1.1
				NICKEL	.00014	LB/GAL	278600	1	39
				PAH	.0000014	LB/GAL	278600	1	0.39
				FORMALDEHYDE	.0001	LB/GAL	278600	1	28

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-TOGIAK	CHROMIUM	.000007	LB/GAL	494900	1	3.5
				MANGANESE	.000004	LB/GAL	494900	1	2.0
				NICKEL	.00014	LB/GAL	494900	1	69
				PAH	.0000014	LB/GAL	494900	1	0.69
				FORMALDEHYDE	.0001	LB/GAL	494900	1	49
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-TOK SOOK BAY	CHROMIUM	.000007	LB/GAL	272400	1	1.9
				MANGANESE	.000004	LB/GAL	272400	1	1.1
				NICKEL	.00014	LB/GAL	272400	1	38
				PAH	.0000014	LB/GAL	272400	1	0.38
				FORMALDEHYDE	.0001	LB/GAL	272400	1	27
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	AK VILLAGE ELECTRIC CO-OP-WALES	CHROMIUM	.000007	LB/GAL	169900	1	1.2
				MANGANESE	.000004	LB/GAL	169900	1	0.68
				NICKEL	.00014	LB/GAL	169900	1	24
				PAH	.0000014	LB/GAL	169900	1	0.24
				FORMALDEHYDE	.0001	LB/GAL	169900	1	17
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	ALASKA ELEC L&P-JUNEAU	CHROMIUM	.000007	LB/GAL	1165000	1	8.2
				MANGANESE	.000004	LB/GAL	1165000	1	4.7
				NICKEL	.00014	LB/GAL	1165000	1	160
				PAH	.0000014	LB/GAL	1165000	1	1.6
				FORMALDEHYDE	.0001	LB/GAL	1165000	1	120
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	BETHEL UTIL CORP-BETHEL	CHROMIUM	.000007	LB/GAL	1900000	1	13
				MANGANESE	.000004	LB/GAL	1900000	1	7.6
				NICKEL	.00014	LB/GAL	1900000	1	270
				PAH	.0000014	LB/GAL	1900000	1	2.7
				FORMALDEHYDE	.0001	LB/GAL	1900000	1	190

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	COPPER VALLEY E ASSN-VALDEZ,GLENNALLEN	CHROMIUM	.000007 LB/GAL	250000	1	1.8
				MANGANESE	.000004 LB/GAL	250000	1	1.0
				NICKEL	.00014 LB/GAL	250000	1	35
				PAH	.0000014 LB/GAL	250000	1	0.35
				FORMALDEHYDE	.0001 LB/GAL	250000	1	25
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	CORDOVA ELEC COOP, INC-CORDOVA	CHROMIUM	.000007 LB/GAL	1350000	1	9.4
				MANGANESE	.000004 LB/GAL	1350000	1	5.4
				NICKEL	.00014 LB/GAL	1350000	1	190
				PAH	.0000014 LB/GAL	1350000	1	1.9
				FORMALDEHYDE	.0001 LB/GAL	1350000	1	140
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	GOLDEN VALLEY E ASSN-FAIRBANKS	CHROMIUM	.000007 LB/GAL	1715000	1	12
				MANGANESE	.000004 LB/GAL	1715000	1	6.9
				NICKEL	.00014 LB/GAL	1715000	1	240
				PAH	.0000014 LB/GAL	1715000	1	2.4
				FORMALDEHYDE	.0001 LB/GAL	1715000	1	170
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	GOLDEN VALLEY E ASSN-YUKON	CHROMIUM	.000007 LB/GAL	100000	1	0.70
				MANGANESE	.000004 LB/GAL	100000	1	0.40
				NICKEL	.00014 LB/GAL	100000	1	14
				PAH	.0000014 LB/GAL	100000	1	0.14
				FORMALDEHYDE	.0001 LB/GAL	100000	1	10
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	HAINES LIGHT & POWER-HAINES	CHROMIUM	.000007 LB/GAL	670000	1	4.7
				MANGANESE	.000004 LB/GAL	670000	1	2.7
				NICKEL	.00014 LB/GAL	670000	1	94
				PAH	.0000014 LB/GAL	670000	1	0.94
				FORMALDEHYDE	.0001 LB/GAL	670000	1	67

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	KETCHIKAN PUBLIC UTILITY-KETCHIKAN	CHROMIUM	.000007	LB/GAL	2690000	1	19
				MANGANESE	.000004	LB/GAL	2690000	1	11
				NICKEL	.00014	LB/GAL	2690000	1	380
				PAH	.0000014	LB/GAL	2690000	1	3.8
				FORMALDEHYDE	.0001	LB/GAL	2690000	1	270
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	KODIAK ELECTRIC ASSN-KODIAK ISLAND	CHROMIUM	.000007	LB/GAL	4420000	1	31
				MANGANESE	.000004	LB/GAL	4420000	1	18
				NICKEL	.00014	LB/GAL	4420000	1	620
				PAH	.0000014	LB/GAL	4420000	1	6.2
				FORMALDEHYDE	.0001	LB/GAL	4420000	1	440
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	KOTZEBUE ELEC ASSN-KOBUK	CHROMIUM	.000007	LB/GAL	1180000	1	8.3
				MANGANESE	.000004	LB/GAL	1180000	1	4.7
				NICKEL	.00014	LB/GAL	1180000	1	170
				PAH	.0000014	LB/GAL	1180000	1	1.7
				FORMALDEHYDE	.0001	LB/GAL	1180000	1	120
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	NAKNEK ELEC-BRISTOL BAY	CHROMIUM	.000007	LB/GAL	1090000	1	7.6
				MANGANESE	.000004	LB/GAL	1090000	1	4.4
				NICKEL	.00014	LB/GAL	1090000	1	150
				PAH	.0000014	LB/GAL	1090000	1	1.5
				FORMALDEHYDE	.0001	LB/GAL	1090000	1	110
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	NOME JOINT UTILITIES-NOME	CHROMIUM	.000007	LB/GAL	1480000	1	10
				MANGANESE	.000004	LB/GAL	1480000	1	5.9
				NICKEL	.00014	LB/GAL	1480000	1	210
				PAH	.0000014	LB/GAL	1480000	1	2.1
				FORMALDEHYDE	.0001	LB/GAL	1480000	1	150

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	NUSHAGAK ELEC COOP-BRISTOL BAY	CHROMIUM	.000007 LB/GAL	860000	1	6.0
				MANGANESE	.000004 LB/GAL	860000	1	3.4
				NICKEL	.00014 LB/GAL	860000	1	120
				PAH	.0000014 LB/GAL	860000	1	1.2
				FORMALDEHYDE	.0001 LB/GAL	860000	1	86
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	PETERSBURG MUNI LIGHT & PWR-PETERSBURG	CHROMIUM	.000007 LB/GAL	1030000	1	7.2
				MANGANESE	.000004 LB/GAL	1030000	1	4.1
				NICKEL	.00014 LB/GAL	1030000	1	140
				PAH	.0000014 LB/GAL	1030000	1	1.4
				FORMALDEHYDE	.0001 LB/GAL	1030000	1	100
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	WRANGELL LIGHT & POWER-WRANGELL	CHROMIUM	.000007 LB/GAL	930000	1	6.5
				MANGANESE	.000004 LB/GAL	930000	1	3.7
				NICKEL	.00014 LB/GAL	930000	1	130
				PAH	.0000014 LB/GAL	930000	1	1.3
				FORMALDEHYDE	.0001 LB/GAL	930000	1	93
4911	ELECTRICITY PRODUCTION	RECIPROCATING DIESEL ENG	SKAGWAY POWER & TELEPHONE-SKAGWAY	CHROMIUM	.000007 LB/GAL	252000	1	1.8
				MANGANESE	.000004 LB/GAL	252000	1	1.0
				NICKEL	.00014 LB/GAL	252000	1	35
				PAH	.0000014 LB/GAL	252000	1	0.35
				FORMALDEHYDE	.0001 LB/GAL	252000	1	25
4911	ELECTRICITY PRODUCTION	TURBINE DIESEL ENG	GOLDEN VALLEY E ASSN-FAIRBANKS	CHROMIUM	.000007 LB/GAL	1850000	1	13
				MANGANESE	.000004 LB/GAL	1850000	1	7.4
				NICKEL	.00014 LB/GAL	1850000	1	260
				PAH	.0000002 LB/GAL	1850000	1	0.37
				FORMALDEHYDE	.00015 LB/GAL	1850000	1	280

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTION	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4931	ELECTRICITY PRODUCTION\OTHER SVCS	COAL COMBUSTION	MUNICIPAL UTILITIES SYS-FAIRBANKS	ARSENIC	.028	LB/TON	230	.05	0.32
				BERYLLIUM	.00083	LB/TON	230	.05	<0.1
				CADMIUM	.0083	LB/TON	230	.05	<0.1
				CHROMIUM	.024	LB/TON	230	.05	0.28
				RADIONUCLIDES	.0027	LB/TON	230	1	0.62
				FORMALDEHYDE	.0032	LB/TON	230	1	0.74
				MANGANESE	.077	LB/TON	230	.05	0.89
				MERCURY	.00038	LB/TON	230	.05	<0.1
				NICKEL	.024	LB/TON	230	.05	0.28
				PAH	.000024	LB/TON	230	1	<0.1
4931	ELECTRICITY PRODUCTION\OTHER SVCS	TURBINE DIESEL ENG	MUNICIPAL UTILITIES SYS-FAIRBANKS	CHROMIUM	.000007	LB/GAL	30000	.05	<0.1
				MANGANESE	.000004	LB/GAL	30000	1	0.12
				NICKEL	.00014	LB/GAL	30000	.05	0.21
				PAH	.0000002	LB/GAL	30000	.05	<0.1
				FORMALDEHYDE	.00015	LB/GAL	30000	1	4.5
4952	SEWERAGE SYSTEMS	SLUDGE INCINERATION	ANCHORAGE WATER AND SEWER-ANCHORAGE	ARSENIC	UNKNOWN	SURVEY DATA	N/A	1	1.7
				BERYLLIUM	UNKNOWN	SURVEY DATA	N/A	1	
				CADMIUM	UNKNOWN	SURVEY DATA	N/A	1	1.5
				CHROMIUM	UNKNOWN	SURVEY DATA	N/A	1	0.3
				LEAD	UNKNOWN	SURVEY DATA	N/A	1	27
				MANGANESE	UNKNOWN	SURVEY DATA	N/A	1	
				MERCURY	UNKNOWN	SURVEY DATA	N/A	1	1.5
				NICKEL	UNKNOWN	SURVEY DATA	N/A	1	0.3
				PAH	UNKNOWN	SEE TEXT	N/A	1	11
				DIBENZOFURAN	UNKNOWN	SEE TEXT	N/A	1	0.6

NOTES: N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4953	WASTE DISPOSAL	MUNICIPAL INCINERATION-MC	NORTH SLOPE BOROUGH-NORTH SLOPE	ARSENIC	.00084	LB/TON	18566	.65	10
				BERYLLIUM	.000021	LB/TON	18566	.65	0.25
				CADMIUM	.0055	LB/TON	18566	.65	66
				CHROMIUM	.034	LB/TON	18566	.65	410
				LEAD	.13	LB/TON	18566	.65	1600
				MANGANESE	.013	LB/TON	18566	.65	160
				NICKEL	.029	LB/TON	18566	.65	350
				PAH	.00012	LB/TON	18566	1	2.2
				FURANS	.000003	LB/TON	18566	1	<0.1
				PCB	.000002	LB/TON	18566	1	<0.1
				DIOXINS	.0000002	LB/TON	18566	1	<0.1
4953	WASTE DISPOSAL	MUNICIPAL INCINERATION-MC	CHANNEL LANDFILL-JUNEAU	ARSENIC	.00084	LB/TON	18200	.08	1.2
				BERYLLIUM	.000021	LB/TON	18200	.08	<0.1
				CADMIUM	.0055	LB/TON	18200	.08	8.0
				CHROMIUM	.034	LB/TON	18200	.08	50
				LEAD	.13	LB/TON	18200	.08	190
				MANGANESE	.013	LB/TON	18200	.08	19
				NICKEL	.029	LB/TON	18200	.08	42
				PAH	.00012	LB/TON	18200	1	2.2
				FURANS	.000003	LB/TON	18200	1	<0.1
				PCB	.000002	LB/TON	18200	1	<0.1
				DIOXINS	.0000002	LB/TON	18200	1	<0.1
4953	WASTE DISPOSAL	MUNICIPAL INCINERATION-MC	CITY OF SITKA-SITKA	ARSENIC	.00084	LB/TON	4774	.06	0.24
				BERYLLIUM	.000021	LB/TON	4774	.06	<0.1
				CADMIUM	.0055	LB/TON	4774	.06	1.6
				CHROMIUM	.034	LB/TON	4774	.06	9.7
				LEAD	.13	LB/TON	4774	.06	37
				MANGANESE	.013	LB/TON	4774	.06	3.7
				NICKEL	.029	LB/TON	4774	.06	8.3
				PAH	.00012	LB/TON	4774	1	0.57
				FURANS	.000003	LB/TON	4774	1	<0.1
				PCB	.000002	LB/TON	4774	1	<0.1
				DIOXINS	.0000002	LB/TON	4774	1	<0.1

NOTES: N/A - NOT AVAILABLE
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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
4953	WASTE DISPOSAL	MUNICIPAL INCINERATION-SC	CITY OF WHITTIER-WHITTIER	ARSENIC	.0018	LB/TON	392	.1	<0.1
				BERYLLIUM	.000045	LB/TON	392	.1	<0.1
				CADMIUM	.012	LB/TON	392	.1	0.47
				CHROMIUM	.074	LB/TON	392	.1	2.9
				LEAD	.29	LB/TON	392	.1	11
				MANGANESE	.027	LB/TON	392	.1	1.1
				NICKEL	.062	LB/TON	392	.1	2.4
				PAH	.00012	LB/TON	392	1	<0.1
				FURANS	.000003	LB/TON	392	1	<0.1
				PCB	.000002	LB/TON	392	1	<0.1
				DIOXINS	.0000002	LB/TON	392	1	<0.1
5171	PETROLEUM BULK STATIONS	PCE DRY CLEANING	CHEVRON USA INC-CORDOVA	PERCHLOROETHYLENE	1	LB/LB USED	8000	1	8000
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-ALEUTIAN ISLANDS	BENZENE	20	LB/TON THC	16	1	320
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	16	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	16	1	0.18
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-ANCHORAGE	BENZENE	20	LB/TON THC	160	1	3200
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	160	1	0.26
				ETHYLENE DICHLORIDE	.011	LB/TON THC	160	1	1.8
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-BRISTOL BAY	BENZENE	20	LB/TON THC	9	1	180
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	9	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	9	1	<0.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-CORDOVA	BENZENE	20	LB/TON THC	4	1	80
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	4	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	4	1	<0.1

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-FAIRBANKS	BENZENE	20	LB/TON THC	37	1	740
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	37	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	37	1	0.41
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-JUNEAU	BENZENE	20	LB/TON THC	26	1	520
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	26	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	26	1	0.29
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-KENAI PENINSULA	BENZENE	20	LB/TON THC	9	1	180
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	9	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	9	1	<0.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-KETCHIKAN	BENZENE	20	LB/TON THC	9	1	180
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	9	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	9	1	<0.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-KOBUK	BENZENE	20	LB/TON THC	12	1	240
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	12	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	12	1	0.13
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-KODIAK ISLAND	BENZENE	20	LB/TON THC	9	1	180
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	9	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	9	1	<0.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-NOME	BENZENE	20	LB/TON THC	22	1	440
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	22	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	22	1	0.24
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-SKAGWAY	BENZENE	20	LB/TON THC	17	1	340
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	17	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	17	1	0.19

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-UPPER YUKON	BENZENE	20 LB/TON THC	3	1	60
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	3	1	<0.1
				ETHYLENE DICHLORIDE	.011 LB/TON THC	3	1	<0.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	CHEVRON USA INC-VALDEZ,CHITINA,WHITTIER	BENZENE	20 LB/TON THC	66	1	1300
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	66	1	0.11
				ETHYLENE DICHLORIDE	.011 LB/TON THC	66	1	0.73
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	TESORO ALASKAN-ANCHORAGE	BENZENE	20 LB/TON THC	241	1	4800
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	241	1	0.39
				ETHYLENE DICHLORIDE	.011 LB/TON THC	241	1	2.7
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	TEXACO-ANCHORAGE	BENZENE	20 LB/TON THC	101	1	2000
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	101	1	0.16
				ETHYLENE DICHLORIDE	.011 LB/TON THC	101	1	1.1
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	TEXACO-FAIRBANKS	BENZENE	20 LB/TON THC	13	1	260
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	13	1	<0.1
				ETHYLENE DICHLORIDE	.011 LB/TON THC	13	1	0.14
5171	PETROLEUM BULK STATIONS	GASOLINE EVAPORATION	UNOCAL-FAIRBANKS	BENZENE	20 LB/TON THC	N/A	1	
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	N/A	1	
				ETHYLENE DICHLORIDE	.011 LB/TON THC	N/A	1	
5963	RETAIL SALES	MUNICIPAL INCINERATION-SC	HACOR-ANCHORAGE	ARSENIC	.0018 LB/TON	1136	1	2.0
				BERYLLIUM	.000045 LB/TON	1136	1	<0.1
				CADMIUM	.012 LB/TON	1136	1	14
				CHROMIUM	.074 LB/TON	1136	1	84
				LEAD	.29 LB/TON	1136	1	330
				MANGANESE	.027 LB/TON	1136	1	31
				NICKEL	.062 LB/TON	1136	1	70
				PAH	.00012 LB/TON	1136	1	0.14
				FURANS	.000003 LB/TON	1136	1	<0.1
				PCB	.000002 LB/TON	1136	1	<0.1
				DIOXINS	.0000002 LB/TON	1136	1	<0.1

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
7216	DRY CLEANING	PCE DRY CLEANING	SNOW WHITE LDY & CLNRS-ANCHORAGE	PERCHLOROETHYLENE	1	LB/LB USED	44000	1	44000
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	ALASKA NATIVE MEDICAL CENTER-ANCHORAGE	ETHYLENE OXIDE	1	LB/LB USED	230	1	230
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	BARTLETT MEMORIAL HOSPITAL-JUNEAU	ETHYLENE OXIDE	1	LB/LB USED	187	1	190
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	BASSETT ARMY HOSPITAL-FT WAINWRIGHT	ETHYLENE OXIDE	1	LB/LB USED	31	1	31
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	CENTRAL PENINSULA HOSPITAL-SOLDOTNA	ETHYLENE OXIDE	1	LB/LB USED	50	1	50
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	FAIRBANKS MEMORIAL HOSPITAL-FAIRBANKS	ETHYLENE OXIDE	1	LB/LB USED	307	1	310
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	HUMANA HOSPITAL-ANCHORAGE	ETHYLENE OXIDE	1	LB/LB USED	269	1	270
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	KETCHIKAN GENERAL HOSPITAL-KETCHIKAN	ETHYLENE OXIDE	1	LB/LB USED	101	1	100
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	PROVIDENCE HOSPITAL-ANCHORAGE	ETHYLENE OXIDE	1	LB/LB USED	405	1	400
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	USAF REGIONAL HOSPITAL-ELMENDORF AFB	ETHYLENE OXIDE	1	LB/LB USED	101	1	100
8062	HOSPITALS	ETHYLENE OXIDE STERILIZERS	VALLEY HOSPITAL-PALMER	ETHYLENE OXIDE	1	LB/LB USED	94	1	94
8062	HOSPITALS	PATHOLOGICAL INCINERATION	FAI COMMUNITY HOSPITAL-FAIRBANKS	FURANS	UNKNOWN		22	1	
				DIOXINS	UNKNOWN		22	1	
				HYDROGEN CHLORIDE	UNKNOWN		22	1	
				OTHERS TO BE DETERMINED	UNKNOWN		22	1	
8211	ELEMENTARY\SECONDARY SCHOOLS	DISTILLATE OIL COMBUSTION	FAI N S BOROUGH SCHOOL DIST-FAIRBANKS	CHROMIUM	.000007	LB/GAL	304700	1	2.1
				FORMALDEHYDE	.000033	LB/GAL	304700	1	10
				MANGANESE	.000004	LB/GAL	304700	1	1.2
				NICKEL	.00014	LB/GAL	304700	1	43
				PAH	1.8E-07	LB/GAL	304700	1	<0.1
				RADIONUCLIDES	UNKNOWN		304700	1	
8211	ELEMENTARY\SECONDARY SCHOOLS	DISTILLATE OIL COMBUSTION	FAI N S BOROUGH SCHOOL DIST-FAIRBANKS	CHROMIUM	.000007	LB/GAL	173000	1	1.2
				FORMALDEHYDE	.000033	LB/GAL	173000	1	5.7
				MANGANESE	.000004	LB/GAL	173000	1	0.69
				NICKEL	.00014	LB/GAL	173000	1	24
				PAH	1.8E-07	LB/GAL	173000	1	<0.1
				RADIONUCLIDES	UNKNOWN		173000	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
8221	COLLEGES\PROFESSIONAL SCHOOLS	COAL COMBUSTION	UNIVERSITY OF ALASKA-FAIRBANKS	ARSENIC	.028	LB/TON	35700	.03	30
				BERYLLIUM	.00083	LB/TON	35700	.03	0.89
				CADMIUM	.0083	LB/TON	35700	.03	8.9
				CHROMIUM	.024	LB/TON	35700	.03	26
				RADIONUCLIDES	.0027	LB/TON	35700	1	96
				FORMALDEHYDE	.0032	LB/TON	35700	1	110
				MANGANESE	.077	LB/TON	35700	.03	82
				MERCURY	.00038	LB/TON	35700	.03	0.41
				NICKEL	.024	LB/TON	35700	.03	26
				PAH	.000024	LB/TON	35700	1	0.86
8221	COLLEGES\PROFESSIONAL SCHOOLS	WASTE OIL COMBUSTION	SHELDON JACKSON COLLEGE-SITKA	ARSENIC	.000042	LB/GAL	150000	1	6.3
				CADMIUM	.000017	LB/GAL	150000	1	2.5
				CHROMIUM	.000083	LB/GAL	150000	1	12
				LEAD	.00083	LB/GAL	150000	1	120
				MANGANESE	UNKNOWN		150000	1	
				NICKEL	UNKNOWN		150000	1	
				PAH	1.8E-07	LB/GAL	150000	1	<0.1
				FORMALDEHYDE	.000033	LB/GAL	150000	1	5.0
9621	REG\ADMIN. OF TRANSP. PROGRAMS	COAL COMBUSTION	DOT THE AK RAILROAD-FAIRBANKS	ARSENIC	.028	LB/TON	4050	.08	9.1
				BERYLLIUM	.00083	LB/TON	4050	.08	0.27
				CADMIUM	.0083	LB/TON	4050	.08	2.7
				CHROMIUM	.024	LB/TON	4050	.08	7.8
				RADIONUCLIDES	.0027	LB/TON	4050	1	11
				FORMALDEHYDE	.0032	LB/TON	4050	1	13
				MANGANESE	.077	LB/TON	4050	.08	25
				MERCURY	.00038	LB/TON	4050	.08	0.12
				NICKEL	.024	LB/TON	4050	.08	7.8
				PAH	.000024	LB/TON	4050	1	<0.1

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9621	REG\ADMIN. OF TRANSP. PROGRAMS	WASTE OIL COMBUSTION	ALASKA DOT FAIRBANKS	ARSENIC	.000042	LB/GAL	N/A	1	
				CADMIUM	.000017	LB/GAL	N/A	1	
				CHROMIUM	.000083	LB/GAL	N/A	1	
				LEAD	.00083	LB/GAL	N/A	1	
				MANGANESE	UNKNOWN		N/A	1	
				NICKEL	UNKNOWN		N/A	1	
				PAH	1.8E-07	LB/GAL	N/A	1	
				FORMALDEHYDE	.000033	LB/GAL	N/A	1	
9711	NATIONAL DEFENSE	AIRPORTS	USAF EIELSON AFB-FAIRBANKS	PAH	UNKNOWN		N/A	1	
				DIOXINS	UNKNOWN		N/A	1	
				FORMALDEHYDE	UNKNOWN		N/A	1	
				XYLENE	282	LB/TON THC	N/A	1	
				BENZENE	13.4	LB/TON THC	N/A	1	
9711	NATIONAL DEFENSE	AIRPORTS	USAF ELMENDORF AFB-ANCHORAGE	PAH	UNKNOWN		N/A	1	
				DIOXINS	UNKNOWN		N/A	1	
				FORMALDEHYDE	UNKNOWN		N/A	1	
				XYLENE	282	LB/TON THC	N/A	1	
				BENZENE	13.4	LB/TON THC	N/A	1	
9711	NATIONAL DEFENSE	COAL COMBUSTION	USAF CLEAR NEWS-NENANA	ARSENIC	.028	LB/TON	CONF	.05	
				BERYLLIUM	.00083	LB/TON	CONF	.05	
				CADMIUM	.0083	LB/TON	CONF	.05	
				CHROMIUM	.024	LB/TON	CONF	.05	
				RADIONUCLIDES	.0027	LB/TON	CONF	1	
				FORMALDEHYDE	.0032	LB/TON	CONF	1	
				MANGANESE	.077	LB/TON	CONF	.05	
				MERCURY	.00038	LB/TON	CONF	.05	
				NICKEL	.024	LB/TON	CONF	.05	
				PAH	.000024	LB/TON	CONF	1	

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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9711	NATIONAL DEFENSE	COAL COMBUSTION	USAF EIELSON AFB-FAIRBANKS	ARSENIC	.028	LB/TON	145000	.01	41
				BERYLLIUM	.00083	LB/TON	145000	.01	1.2
				CADMIUM	.0083	LB/TON	145000	.01	12
				CHROMIUM	.024	LB/TON	145000	.01	35
				RADIONUCLIDES	.0027	LB/TON	145000	1	390
				FORMALDEHYDE	.0032	LB/TON	145000	1	460
				MANGANESE	.077	LB/TON	145000	.01	110
				MERCURY	.00038	LB/TON	145000	.01	0.55
				NICKEL	.024	LB/TON	145000	.01	35
				PAH	.000024	LB/TON	145000	1	3.5
9711	NATIONAL DEFENSE	COAL COMBUSTION	US ARMY FT. WAINWRIGHT-FAIRBANKS	ARSENIC	.028	LB/TON	147100	.14	580
				BERYLLIUM	.00083	LB/TON	147100	.14	17
				CADMIUM	.0083	LB/TON	147100	.14	170
				CHROMIUM	.024	LB/TON	147100	.14	490
				RADIONUCLIDES	.0027	LB/TON	147100	1	400
				FORMALDEHYDE	.0032	LB/TON	147100	1	470
				MANGANESE	.077	LB/TON	147100	.14	1600
				MERCURY	.00038	LB/TON	147100	.14	7.8
				NICKEL	.024	LB/TON	147100	.14	490
				PAH	.000024	LB/TON	147100	1	3.5
9711	NATIONAL DEFENSE	FREON DRY CLEANING	US NAVY ADAK NAVAL AIR STATION-ADAK	FREON 113	1	LB/LB USED	N/A	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	USAF SHEMYA AFB-SHEMYA	CHROMIUM	.000007	LB/GAL	2640000	1	18
				FORMALDEHYDE	.000033	LB/GAL	2640000	1	87
				MANGANESE	.000004	LB/GAL	2640000	1	11
				NICKEL	.00014	LB/GAL	2640000	1	370
				PAH	1.8E-07	LB/GAL	2640000	1	0.48
				RADIONUCLIDES	UNKNOWN		2640000	1	

NOTES: N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	USAF CAPE NENENHAM AFS-PLATINUM	CHROMIUM	.000007 LB/GAL	878000	1	6.1
				FORMALDEHYDE	.000033 LB/GAL	878000	1	29
				MANGANESE	.000004 LB/GAL	878000	1	3.5
				NICKEL	.00014 LB/GAL	878000	1	120
				PAH	1.8E-07 LB/GAL	878000	1	0.16
				RADIONUCLIDES	UNKNOWN	878000	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US ARMY FT GREELEY-DELTA	CHROMIUM	.000007 LB/GAL	2380000	1	17
				FORMALDEHYDE	.000033 LB/GAL	2380000	1	79
				MANGANESE	.000004 LB/GAL	2380000	1	9.5
				NICKEL	.00014 LB/GAL	2380000	1	330
				PAH	1.8E-07 LB/GAL	2380000	1	0.43
				RADIONUCLIDES	UNKNOWN	2380000	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US ARMY FT RICHARDSON-ANCHORAGE	CHROMIUM	.000007 LB/GAL	1300000	1	9.1
				FORMALDEHYDE	.000033 LB/GAL	1300000	1	43
				MANGANESE	.000004 LB/GAL	1300000	1	5.2
				NICKEL	.00014 LB/GAL	1300000	1	180
				PAH	1.8E-07 LB/GAL	1300000	1	0.23
				RADIONUCLIDES	UNKNOWN	1300000	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US ARMY FT WAINWRIGHT-FAIRBANKS	CHROMIUM	.000007 LB/GAL	3754000	1	26
				FORMALDEHYDE	.000033 LB/GAL	3754000	1	120
				MANGANESE	.000004 LB/GAL	3754000	1	15
				NICKEL	.00014 LB/GAL	3754000	1	530
				PAH	1.8E-07 LB/GAL	3754000	1	0.68
				RADIONUCLIDES	UNKNOWN	3754000	1	

NOTES: N/A - NOT AVAILABLE
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ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR		ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US NAVY SECURITY GROUP ACTIVITY-ADAK	CHROMIUM	.000007	LB/GAL	3258000	1	23
				FORMALDEHYDE	.000033	LB/GAL	3258000	1	110
				MANGANESE	.000004	LB/GAL	3258000	1	13
				NICKEL	.00014	LB/GAL	3258000	1	460
				PAH	1.8E-07	LB/GAL	3258000	1	0.59
				RADIONUCLIDES	UNKNOWN		3258000	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US NAVY ADAK NAVAL AIR STN-ADAK	CHROMIUM	.000007	LB/GAL	15993000	1	110
				FORMALDEHYDE	.000033	LB/GAL	15993000	1	530
				MANGANESE	.000004	LB/GAL	15993000	1	64
				NICKEL	.00014	LB/GAL	15993000	1	2200
				PAH	1.8E-07	LB/GAL	15993000	1	2.9
				RADIONUCLIDES	UNKNOWN		15993000	1	
9711	NATIONAL DEFENSE	DISTILLATE OIL COMBUSTION	US COAST GUARD-KODIAK	CHROMIUM	.000007	LB/GAL	3484653	1	24
				FORMALDEHYDE	.000033	LB/GAL	3484653	1	110
				MANGANESE	.000004	LB/GAL	3484653	1	14
				NICKEL	.00014	LB/GAL	3484653	1	490
				PAH	1.8E-07	LB/GAL	3484653	1	0.63
				RADIONUCLIDES	UNKNOWN		3484653	1	
9711	NATIONAL DEFENSE	GASOLINE EVAPORATION	US ARMY FT WAINWRIGHT-FAIRBANKS	BENZENE	20	LB/TON THC	6	1	120
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	6	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	6	1	<0.1
9711	NATIONAL DEFENSE	GASOLINE EVAPORATION	PETROLEUM DIRECTORATE-ANCHORAGE	BENZENE	20	LB/TON THC	35	1	700
				ETHYLENE DIBROMIDE	.0016	LB/TON THC	35	1	<0.1
				ETHYLENE DICHLORIDE	.011	LB/TON THC	35	1	0.39

NOTES:
N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9711	NATIONAL DEFENSE	GASOLINE EVAPORATION	PETROLEUM DIRECTORATE-WHITTIER	BENZENE	20 LB/TON THC	52	1	1000
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	52	1	<0.1
				ETHYLENE DICHLORIDE	.011 LB/TON THC	52	1	0.57
9711	NATIONAL DEFENSE	GASOLINE EVAPORATION	US NAVY ADAK NAVAL AIR STN-ADAK	BENZENE	20 LB/TON THC	60	1	1200
				ETHYLENE DIBROMIDE	.0016 LB/TON THC	60	1	<0.1
				ETHYLENE DICHLORIDE	.011 LB/TON THC	60	1	0.66
9711	NATIONAL DEFENSE	MUNICIPAL INCINERATION-SC	USAF KING SALMON AFB-	ARSENIC	.0018 LB/TON	291	1	0.52
				BERYLLIUM	.000045 LB/TON	291	1	<0.1
				CADMIUM	.012 LB/TON	291	1	3.5
				CHROMIUM	.074 LB/TON	291	1	22
				LEAD	.29 LB/TON	291	1	84
				MANGANESE	.027 LB/TON	291	1	7.9
				NICKEL	.062 LB/TON	291	1	18
				PAH	.00012 LB/TON	291	1	<0.1
				FURANS	.000003 LB/TON	291	1	<0.1
				PCB	.000002 LB/TON	291	1	<0.1
				DIOXINS	.0000002 LB/TON	291	1	<0.1
9711	NATIONAL DEFENSE	MUNICIPAL INCINERATION-SC	USAF SHEMYA AFB-SHEMYA	ARSENIC	.0018 LB/TON	1007	1	1.8
				BERYLLIUM	.000045 LB/TON	1007	1	<0.1
				CADMIUM	.012 LB/TON	1007	1	12
				CHROMIUM	.074 LB/TON	1007	1	75
				LEAD	.29 LB/TON	1007	1	290
				MANGANESE	.027 LB/TON	1007	1	27
				NICKEL	.062 LB/TON	1007	1	62
				PAH	.00012 LB/TON	1007	1	0.12
				FURANS	.000003 LB/TON	1007	1	<0.1
				PCB	.000002 LB/TON	1007	1	<0.1
				DIOXINS	.0000002 LB/TON	1007	1	<0.1

NOTES: N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

ALASKA AIR TOXICS STUDY

POINT SOURCE EMISSION INVENTORY

SIC	SIC DESCRIPTOR	EMISSION SOURCE	FACILITY NAME-AREA	POLLUTANT	EMISSION FACTOR	ACTIVITY DATA	CONTROL FACTOR	EMISSIONS LBS/YEAR
9711	NATIONAL DEFENSE	WASTE OIL COMBUSTION	US ARMY FT WAINWRIGHT-FAIRBANKS	ARSENIC	.000042 LB/GAL	160300	1	6.7
				CADMIUM	.000017 LB/GAL	160300	1	2.7
				CHROMIUM	.000083 LB/GAL	160300	1	13
				LEAD	.00083 LB/GAL	160300	1	130
				MANGANESE	UNKNOWN	160300	1	
				NICKEL	UNKNOWN	160300	1	
				PAH	1.8E-07 LB/GAL	160300	1	<0.1
				FORMALDEHYDE	.000033 LB/GAL	160300	1	5.3
9711	NATIONAL DEFENSE	WASTE OIL COMBUSTION	US COAST GUARD-KODIAK	ARSENIC	.000042 LB/GAL	60000	1	2.5
				CADMIUM	.000017 LB/GAL	60000	1	1.0
				CHROMIUM	.000083 LB/GAL	60000	1	5.0
				LEAD	.00083 LB/GAL	60000	1	50
				MANGANESE	UNKNOWN	60000	1	
				NICKEL	UNKNOWN	60000	1	
				PAH	1.8E-07 LB/GAL	60000	1	<0.1
				FORMALDEHYDE	.000033 LB/GAL	60000	1	2.0

NOTES:
N/A - NOT AVAILABLE
CONF - THIS DATA IS CONFIDENTIAL

APPENDIX B

EMISSION FACTOR DOCUMENTATION

AIRPORT OPERATIONS

The emission factor for benzene was calculated from CARB 1982b, which provided a species profile for jet exhaust. Benzene comprised 0.067 percent of the THC emissions.

EF = (.067)(2,000 lb)/ton THC
= 13.4 lb/ton THC

The emission factor for xylene was also calculated from CARB 1982b. Xylene comprised 14.1 percent of the THC emissions.

EF = (.141)(2,000 lb)/ton THC
= 282 lb/ton THC

ASPHALT CEMENT PLANTS

1. Benzene

The emission factor for benzene was calculated from data presented in EPA, 1984a and EPA, 1980:

- VOC emission factor for asphalt production is reported as 0.028 lb/ton (U.S. EPA, 1984a, p. 8.1-7), and

- Benzene comprises 9.5% (by weight) of the VOC emissions from asphalt production (U.S. EPA, 1980, p. 3.05-12).

This data yields the following emission factor:

EF = (0.028 lb/ton) (0.095)
= 0.0027 lb benzene/ton of asphalt

2. PAH

The emission factor for PAHs was taken directly from U.S. EPA 1984a, p. 8.1-7.

3. Formaldehyde

The emission factor for formaldehyde was taken directly from U.S. EPA 1984a, p. 8.1-7.

ASPHALT DISTRIBUTION AND USAGE

1. Asphalt Cement (Hot Mix)

According to CARB, 1982a, the application of hot mix asphalt emits 0.8 pounds of VOC per ton as asphalt applied. To speciate these emissions, speciation data for emissions from an asphalt plant were used (U.S. EPA, 1984a, p. 8.1-7).

Species	% of Total Hydrocarbon
Benzene	9.6
Formaldehyde	0.5
PAH	0.1

This data yields the following emission factors

Species	Emission Factor (lb/ton)
Benzene	0.077
Formaldehyde	0.0040
PAH	0.0008

2. Cut Back Asphalt

The emission factors for toluene and xylene were taken directly from Radian 1985, p.32.

COAL COMBUSTION

1. Inorganics

Emission factors for inorganic emissions were developed from data presented by Delleny, 1981. The following information was obtained from this document:

- Average trace element composition of western coals, page 11. These data were originally obtained from the Coal Research Section of Penn State. The data are part of the Penn State coal database. Where individual elemental data were missing in the Penn State data base, data from the Illinois Geological Survey of 1975 were used.

- Partition coefficients, or the percent of trace metals entering the combustor that end up in the fly ash, were taken from page A-8. Data is presented for 2 tangentially-fired pulverized coal boilers and 1 cyclonic boiler. The data from all three were averaged together.

The emission factors developed from this data are presented in the following table.

Metal	Avg. Concentration (lb/10^6 lb coal)	Avg. Partition Coefficient %	Uncontrolled Emission Factor (lb/ton)
Arsenic	15	92	0.028
Beryllium	0.59	70	0.00083
Cadmium	5	83	0.0083
Chromium	15.5	77	0.024
Manganese	55.8	69	0.077
Mercury	0.19	99	0.00038
Nickel	14.9	82	0.024
Radionuclides*	0.6 + 1.45	67	0.0027

Sample emission factor calculation for arsenic:

(15 lb/10^6 lb) (2000 lb/ton) (0.92) = 0.028 lb/ton

* Sum of thorium and uranium, respectively.

2. Formaldehyde

Various emission factors for formaldehyde are presented in U.S. EPA, 1985b. The following emission factors are given:

	ng/J
Pulverized Coal	0.048
Chain Grate Stoker	0.060
Spreader Stoker	0.095
Underfed Stoker	0.53
Hand Stoked	0.027

Due to the number of coal combustion sources in the inventory, it is not possible to use the specific individual emission factors listed above. Compared to the others, the EF for the underfed stoker is quite high; therefore, this value will be excluded. An average of the other 4 values yields an emission factor of 0.058 ng/J. This value can be converted to a mass basis by assuming coal has a heating value of 12,000 Btu per pound.

$$(0.058\ \text{ng/J})(1\ \text{gm}/10^{9}\ \text{ng})(1\ \text{lb}/454\ \text{gm})(1055\ \text{J/Btu})(12{,}000\ \text{Btu/ton})(2000\ \text{lb/ton})$$

$$= \underline{\underline{0.0032\ \text{lb/ton}}}$$

3. PAH

An emission factor for PAH was obtained from Kelly, 1983. This document presents the following range of emission factors for POM:

7×10^{-6} to 4×10^{-5} lb/ton (Controlled by ESP)

It will be assumed, for the purposes of obtaining an emission factor, that PAH is equivalent to POM. Furthermore, the mid-point of this range or 2.4×10^{-5} will be used as the emission factor.

DISTILLATE OIL COMBUSTION

Emission factors for distillate oil combustion were taken directly from Radian 1984b. The emission factor for PAH was assumed to be equivalent to the emission factor for POM.

Pollutant	Emission Factor ($lb/10^3$ gal)
Chromium	0.007
Formaldehyde	0.033
Manganese	0.004
Nickel	0.14
PAH	0.000175

DRY CLEANING

1. Area Sources

The emission factor for dry cleaning area sources was taken directly from U.S. EPA, 1984a. According to this document, 1.3 lb solvent/capita/year is used. Perchloroethylene (PCE) was assumed to be the only solvent used.

2. Point Source

Emission factors were not used for dry cleaning point sources. Actual emissions estimates are provided in NEDS.

ELECTROPLATING

1. Chromium

Based on our analysis of the process by which metals emissions are generated during electroplating and our analysis of the available data on emissions, we feel that emission factors expressed as the mass of metal emitted per ampere per hour best incorporate the available data and best predict emissions. In addition, such emission factors are able to explain the difference in emissions which have been observed between industrial (hard) and decorative plating operations. It appears that those differences are caused primarily by variations in the current density used in the two types of electroplating operations.

Several studies measured uncontrolled chromium emissions and electroplating current simultaneously (Entropy Environmentalists, 1986; Powers and Forester, 1985; Daley, 1977; Diamond, 1969). Emission factors reported in and derived from these studies are shown in Table B-1. Although emission factors for both hexavalent and total chromium are shown in one case, only total chromium emission factors were used.

The values shown in Table B-1 range from $1.7\text{x}10^{-3}$ g Cr/hr/Ampere to $5.0\text{x}10^{-3}$ g Cr/hr/Ampere. In emission calculations, the average of the values reported in the table, $3.4\text{x}10^{-3}$ g Cr/hr/Ampere (7.5×10^{-6} lb/Cr/hr/Ampere), was used.

2. Nickel

Emission factors for nickel have not been identified. However, Daley (1977) simultaneously measured uncontrolled nickel emissions and current for a nickel striking operation. A striking operation is an electrodeposition operation in which a very thin film of metal is plated into a base material to facilitate further plating with another metal or with the same metal. The emission factor measured by Daley for the nickel strike operation is $2.25\text{x}10^{-4}$ gm Ni/hr/ampere. For lack of any available data for actual nickel plating operations, this factor was used to estimate emissions.

3. Cadmium

Uncontrolled cadmium emissions and electroplating current were simultaneously measured by Powers and Forester (1985), and Daley (1977). Emission factors reported in or derived from these studies are $4.5\text{x}10^{-5}$ gm cd/hr/ampere and $5.0\text{x}10^{-5}$ gm cd/hr/ampere, respectively. Since both of these factors round off to $5.0\text{x}10^{-5}$ gm cd/hr/ampere, this factor was used in the cadmium emission calculations.

The emission factor reported by Daley was taken from Table 7. Derivation of the emission factor from the Powers and Forester data is presented below.

TABLE B-1.

SUMMARY OF EMISSION FACTORS FOR CHROME PLATING

Reference	Type of Plating	Number of Data Points	Emission Factor EF (g/hr/A)[1]
Entropy Envrionmentalists, 1986	Hard	3	$1.7\times10^{-3} - 3.4\times10^{-3}$ (Cr^t) $8.0\times10^{-4} - 1.7\times10^{-3}$ (Cr^{+6})
Powers and Forester, 1985	Hard	3	$2.1\times10^{-3} - 5.0\times10^{-3}$ (Cr^t)
Daley, 1977	Hard	33	5.0×10^{-3} (Cr^t)

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[1] grams per hour per ampere of current

Powers and Forester (1985) present data that can be used to calculate an emission factor for cadmium plating in terms of mg cd/hr/ampere. The emission factor will be calculated based on data presented in the report for Line A. Line A contained several heavy metal plating operations including a silver strip, zinc plate, brass plate, and cadmium plate. Apparently, the combined emissions from Line A were determined. However, cadmium emissions will only result from the cadmium plating operation since this is the only operation in which cadmium is present in the plating bath (see Table 1, Page 6, for both compositions). Therefore, the cadmium rate from the line was used to calculate a cadmium emission factor for cadmium plating.

The following data were reported:

Test Run #	⑤ Current in Cadmium Plate Tank (Amps)[a]	④ Air Flow Rate From Line A (SCFM)[b]	① Total Amount of Cadmium Collected in Sampling System (mg)[c]	② Volume of Air Sampled (M^3)[c]
1	240	7,665	0.0015	2.057
2	300	7,681	0.0013	2.053
3	300	7,390	0.0034	1.981

Test Run #	③ Cadmium Concentration (mg/m^3)[d]	⑥ Cadmium Emission Rate (lb/hr)[e]	Cadmium Emission Factor (lb/amp-hr)[f]
1	0.00073	0.000021	$8.8x10^{-8}$
2	0.00063	0.000018	$6.0x10^{-8}$
3	0.0017	0.000047	$1.6x10^{-7}$

AVG = $1.0x10^{-7}$ lb/amp-hr
= 0.045 mg/amp-hr

a Data from Table 5, Page 10
b Data from Table 8, Page 24
c Data from Table 17, Page 36
d Cadmium concentration = ①/②
e Cadmium emission rate = ③ x ④ x $\frac{m^3}{35.315\ ft^3}$ x $\frac{1\ lb}{453600\ mg}$ x $\frac{60\ min}{hr}$
f Cadmium emission factor = ⑥/⑤

ETHYLENE OXIDE STERILIZERS

In most hospitals, ethylene oxide (EtO) is removed from the sterilization chamber by a water sealed pump. The pump emits some EtO directly to the air; the remaining EtO is sent into the sewage system in solution. However, the slow reaction rate of EtO in water under near-neutral pH conditions, combined with its highly volatility, causes most of the dissolved EtO to volatilize from the water. For this reason, we have assumed a unit "emission factor" - the entire amount of EtO used is assumed to be emitted.

GASOLINE EVAPORATION

1. Benzene

The emission factor for benzene was calculated from data and information obtained from CARB, 1984. See pages I-2 and F-3. The following information was used:

- The emissions from gasoline marketing consist of 1.0 weight percent benzene; and
- For gasoline evaporation, a ton of TOG equals a ton of THC.

This information yields the following emission factor:

EF = (1 lb benzene/100 lb THC)(2000 lb/1 ton)(1 ton THC/1 ton TOG)

= 20 lb benzene/ton TOG

2. Ethylene Dibromide

The following information is available to calculate on ethylene dibromide (EDB) emission factor:

- EDB emission factor for leaded gasoline is 2.1×10^{-5} lb/lb THC (CARB, 1984; page F-3.)
- 41.2% of the estimated THC emissions from gasoline evaporation are from leaded gasoline.

In 1984, the allowable lead content of gasoline was 1.1 gram/gal. Effective January, 1986, the allowable lead content of gasoline was reduced to 0.1 gm/gal. A corresponding decrease in EDB content will also be seen. This information yields the following emission factor:

$$EF = (2.1 \times 10^{-5} \text{ lb EDB/lb THC})(2000 \text{ lb/ton})(0.412)\ \frac{(0.1)}{(1.1)}$$

= 0.0016 lb EDB/ton THC

3. Ethylene Dichloride

The emission factor for ethylene dichloride (EDC) was developed using the emission factor for EDB calculated above and the information and data presented by KVB Inc., 1980. See pages 3-99, and 3-100. The following information is given:

- The weight ratio for EDB to EDC is 0.294:0.304.
- The vapor pressure of EDC at 77°F is 77 Torr, while the vapor pressure of EDB at this same temperature is 12 Torr.

Correcting for the relative volatilities and using the given weight ratio yields the following emission factor:

$$\text{EF} = (0.0016\ \text{lb EDB/ton TOG})(0.304\ \text{lb EDC}/0.294\ \text{lb EDB})(77\ \text{torr}/12\ \text{torr})$$

$$= \underline{0.011\ \text{lb EDC/ton TOG})}$$

MOBILE SOURCES

1. Gasoline Combustion

An emission factor for gasoline combustion can be developed by combining the total hydrocarbon emission factor with hydrocarbon speciation data. Total hydrocarbon emissions from gasoline engines, 2.5 gm/mile, was taken directly from Radian, 1984. Speciation data (as weight %) for car exhaust is shown below:

		EPA, 1980			
Compound	SAI, 1982	1	2	3	Average
Benzene	ND	1.0	3.9	1.8	2.2
Formaldehyde	ND	6.9	4.7	ND	5.8
Toluene	12	9.6	12	9.1	10.6
Xylene	3.4	3.0	3.6	0.8	2.7

These data yield the following emission factors:

Benzene = (2.5 g/mile)(1 lb/454 g)(0.022) = $\underline{1.2 \times 10^{-4}\ \text{lb/mile}}$

Formaldehyde = (2.5 g/mile)(1 lb/454 g)(0.058) = $\underline{3.2 \times 10^{-4}\ \text{lb/mile}}$

Toluene = (2.5 g/mile)(1 lb/454 g)(0.106) = $\underline{5.8 \times 10^{-4}\ \text{lb/mile}}$

Xylene = (2.5 g/mile)(1 lb/454 g)(0.027) = $\underline{1.5 \times 10^{4}\ \text{lb/mile}}$

2. Diesel Combustion

The same methodology as was used for gasoline consumption was used for diesel consumption. Total hydrocarbon emissions from a diesel vehicle were estimated to be 3.85 g/mile (U.S. EPA, 1984a). Speciation data (as weight %) for diesel exhaust is show below:

Hyrdocarbon Composition of Vehicle Exhaust
(Percent by Weight)

Compound	Weight
Benzene	1.9
Formaldehyde	12.2
Toluene	1.8
Xylene	0.3

These data were obtained from U.S. EPA, 1984a; and U.S. EPA, 1980. These data yield the following emission factors:

Benzene = (3.85 g/mile)(1 lb/454 g)(0.019) = 1.6×10^{-4} lb/mile

Formaldehyde = (3.85 g/mile)(1 lb/454 g)(0.122) = 1.0×10^{-3} lb/mile

Toluene = (3.85 g/mile)(1 lb/454 g)(0.018) = 1.5×10^{-4} lb/mile

Xylene = (3.85 g/mile)(1 lb/454 g)(0.003) = 2.5×10^{-5} lb/mile

MUNICIPAL SOLID WASTE INCINERATION

Based on Radian's experience with waste to energy facilities it is our judgement that the emission factors developed for the Irwindale Resource Recovery facility are the most comprehensive set of emission factors available (see California Energy Commission Docket 84-AFC-5).

1. Metals

The Irwindale emission factors are actually a compilation of emission factors from several modern MSW incinerators with high efficiency air pollution control devices. However, the types of controls and corresponding efficiencies for these facilities is unknown. Consequently, the best use of the Irwindale data is to use this data to speciate particulate matter from a MSW incinerator. Speciation data compiled for the Irwindale project for selected metals are presented below:

Parameter	Reported emission factor* (ug/MJ)	Fraction of Particulate Matter (Wt %)
Arsenic	0.94	0.012
Beryllium	0.023	0.0003
Cadmium	6.20	0.079
Chromium	38.5	0.49
Lead	149	1.9
Manganese	14.1	0.18
Mercury	107	—
Nickel	32.2	0.41

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* Controlled emission factors; degree of control is unknown.

Particulate matter emission factors for municipal waste incineration were obtained from the following document:

> State of California Air Resources Board Technical Support Division, Instructions for the Emission Data System Review and Update Report, Appendix III, Source Classification Codes and EPA/AP-42 Emission Factors, Revised, March 1985.

SCC	Incinerator Design	PM Emission Rate (lbs/ton burned)
5-02-001-01	Multiple Chamber	7.0
-02	Single Chamber	15.0
-03	Controlled Air	1.4

With PM emission factors, air toxic emission factors can be calculated as shown below. Where the incinerator design is unknown, we will use the single chamber emission factors in order to develop worst-case emission factors.

Parameter	Multiple Chamber (lb/ton)	Single Chamber (lb/ton)	Controlled Air (lb/ton)
Arsenic	0.84×10^{-3}	1.8×10^{-3}	0.168×10^{-3}
Beryllium	0.021×10^{-3}	0.045×10^{-3}	0.004×10^{-3}
Cadmium	5.5×10^{-3}	0.012	1.1×10^{-3}
Chromium	0.034	0.074	6.8×10^{-3}
Lead	0.13	0.29	0.027
Manganese	0.013	0.027	2.5×10^{-3}
Nickel	0.029	0.062	5.7×10^{-3}

Example Calculation:

Uncontrolled Arsenic emissions from a Multiple Chamber Incinerator

= (0.012 lb As/100 lb PM)(7 lb PM/ton MSW) = $\underline{0.84 \times 10^{-3}}$ lb As/ton MSW

2. Organics

Emissions data for various organic constituents are also presented in the Irwindale data. For these parameters, however, speciation data are not provided, only emission factors expressed as ug/MJ. These emission factors will be converted to a mass basis by assuming MSW has a heating value of 5,000 Btu/lb.

Parameter	Irwindale Emission Factors (ug/MJ)	Converted Emission Factors (lb/ton)
PAHs	5.02	0.12×10^{-3}
PCBs	0.10	0.002×10^{-3}
PCDDs	0.068	0.0002×10^{-3}
PCDFs	0.15	0.003×10^{-3}

Sample Calculation for PAHs:

$(5.02\ \text{ug}/10^6\text{J})(1055\ \text{J/Btu})(5000\ \text{Btu/lb})(1\text{gm}/10^6\text{ug})(1\ \text{lb}/454\text{gm})(2000\ \text{lb/ton})$

$= (5.02\ \text{ug}/10^6\text{J})(23.2)$

$= \underline{0.12 \times 10^{-3}\ \text{lb/ton}}$

OIL REFINERY FUGITIVES

Oil refinery fugitives consist of emissions from leaking, valves, flanges, pumps, etc. In a study for EPA, Radian performed a detailed analysis for the composition of oil refinery fugitives. This study concluded that for a model refinery, fugitive emissions consisted of 0.72 percent benzene and 3.1 percent xylene. The model refinery was a large integrated refinery with cracking, reforming, and aromatics extraction operations. These estimates were made using the following procedures (Radian, 1980):

- The composition of various process streams were analyzed. The results of these analyses are shown in Table 1.
- The emissions from each process unit were allocated to various process streams in order to estimate the composition of emissions from that process unit. An example of this calculation is shown in Table 2 for a fluid catalytic cracking unit.
- The emissions from all process units in a model refinery were aggregated to estimate the overall composition of refinery fugitives. The results of this calculation are shown in Table 3.

In order to apply these emission factors for benzene and xylene to refineries in Alaska, we must account for the fact that none of the Alaska refinereis have aromatics extraction. We must also account for the fact that the refineries in Alaska do not have process units that produce streams with relatively high benzene and xylene concentrations, such as cracking and reforming.

Radian has reviewed the existing literature and found a wide variety of benzene emission factors for refinery fugitives from approximately 0.01 to 1.0 percent. Given the large amount of uncertainty that exists, Radian has selected the following conservative approach that should result in an overestimation of emissions.

- For refineries that have cracking or reforming operations, we assumed emission factos that are 50 percent of Radian's results.

Benzene	0.36 percent = 7.2 lb benzene/ton THC
Xylene	1.55 percent = 31.0 lb xylene/ton THC
Toluene	1.05 percent = 21.0 lb toluene/ton THC

- For refineries without cracking or reforming operations, we assumed emission factos that are one order of magnitude below the emission factors listed directly above.

Benzene	0.036 percent = 0.72 lb benzene/ton THC
Xylene	0.155 percent = 3.1 lb xylene/ton THC
Toluene	0.105 percent = 2.1 lb toluene/ton THC

The determination of whether refineries have cracking or reforming operations was made using the 1986 issue of the Oil and Gas Journal's Annual Refining Survey. If refineries were not included in the survey it was assumed that they did not have cracking or reforming operations.

It should be noted that the selection of emission factors that are 50 percent of Radian's results for refineries with cracking or reforming operations (but without aromatics production) and the selection of emission factors that are an order of magnitude lower for refineries without cracking or reforming operations is subjective. However, these decisions represent a best engineering judgement based on an evaluation of the stream composition data presented in Table 1.

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TABLE 1. SUMMARY OF STREAM QUALITY DATA (PPMW)[a]

Compound or Functional Family	Crude Oil	Straight Run Naphtha	Middle Distillate	Atmospheric Gas & Oil	Vacuum Gas & Oil	Reformate	H_2 Recycle Gas	Desulfurized Naphtha
Benzene	60	253	0	0	0	5,400	0	253
Toluene	680	2,621	5	8	5	77,700	0	2,621
Ethylbenzene	220	887	9	6	6	33,500	0	887
Xylenes	880	1,623	52	16	22	170,900	0	1,623
Other Alkylbenzenes	3,739	16,578	835	61	368	324,400	0	16,578
Naphthalene	260	1,463	100	4	28	7,400	0	1,463
Anthracene	140	5	56	3	12	0	0	5
Biphenyl	320	628	0	0	9	0	0	628
Other PNA's	7,880	14,983	5,507	220	663	700	0	14,983
n-Hexane	18,000	38,838	0	0	0	24,000	0	38,838
Other Alkanes	877,240	499,613	842,536	949,673	948,887	356,000	650,000	499,613
Olefins	0	0	0	0	0	0	0	0
Cycloalkanes	58,300	422,508	100,000	50,000	50,000	0	0	422,508
Other Compounds Indicated Present	Carbonyl ≃ 500 ppm Thiols ≃ 25,000 ppm Sulfides ≃ 6,000 ppm Quinolines ≃ 200 ppm Pyridines	Pyridines Thiols Sulfides	Pyridines Thiols Sulfides ≃ 51,000 ppm Quinolines	Pyridines Thiols Sulfides Quinolines ≃ 9 ppm	Pyridines Thiols Sulfides Quinolines		H_2 ≃ 350,000	

Continued

TABLE 1. (Continued)

Compound or Functional Family	Hydrotreated Middle Distillate	Refinery Fuel Gas	Liquefied Petroleum Gas (LPG)	Raffinate	Aromatics Extract	Benzene	Toluene	Xylenes
Benzene	0	0	0	50	17,840	993,000	1,000	0
Toluene	5	0	0	750	256,700	2,000	992,800	1,000
Ethylbenzene	9	0	0	300	110,670	0	4,000	162,420
Xylenes	52	0	0	1,500	564,590	0	1,000	828,580
Other Alkylbenzenes	835	0	0	2,300	48,000	0	0	5,000
Naphthalene	100	0	0	50	100	0	0	100
Anthracene	56	0	0	0	0	0	0	0
Biphenyl	0	0	0	0	0	0	0	0
Other PNA's	5,507	0	0	50	100	0	0	100
n-Hexane	0	0	0	63,000	100	5,000	0	0
Other Alkanes	887,436	920,000	1,000,000	932,000	1,900	0	1,200	2,800
Olefins	0	60,000	0	0	0	0	0	0
Cycloalkanes	100,000	0	0	0	0	0	0	0
Other Compounds Indicated Present	Sulfides $\cong$ 6,000 ppm	$H_2 \cong 20,000$ Thiols Sulfides	Thiols Sulfides					

(Continued)

TABLE 1. (Continued)

Compound or Functional Family	LPG Olefins	Alkylate	Cracked Naphtha	FCC Light Cycle Gas & Oil[a]	FCC Heavy Cycle Gas & Oil	Heavy Aromatics Extract (SO_2 Plant)	Asphalt	API Separator Skim Oil	Vacuum Resid
Benzene	0	0.1	2,880	0	740	0	0	87	0
Toluene	0	0.3	89,780	40	10,000	0	0	1,713	0
Ethylbenzene	0	0.1	21,430	0	1,200	0	0	661	0
Xylenes	0	1.1	171,450	610	11,800	0	0	2,510	0
Other Alkylbenzenes	0	3.3	243,470	26,670	38,200	750,000	ℓ[b]	12,751	ℓ
Naphthalene	0	0.3	10,950	59,000	14,000	0	0	990	0
Anthracene	0	0	0	10,270	0	0	2	457	2
Biphenyl	0	0	0	10,180	0	0	0	2,351	0
Other PNA's	0	2.2	6,480	624.480	22,500	200,000	200	29,700	200
n-Hexane	0	96	11,830	0	0	0	0	ℓ	0
Other Alkanes	400,000	998,956	204,110	190,800	701,560	45,000	999,798	948,780	999,798
Olefins	600,000	930	170,740	36,750	50,000	0	ℓ	ℓ	
Cycloalkanes	0	11	68,880	41,200	150,000	5,000	ℓ	ℓ	
Other Compounds Indicated Present	Thiols		Pyridines Thiols Sulfides Quinolines	Phenols Carbonyls Pyridines Thiols Sulfides Quinolines	Pyridines Carbonyls Thiols Sulfides Quinolines				

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[a] Compositions are estimated to 2 or 3 significant figures. Additional significant figures are a result of calculational procedures, and they should not be given any importance.

[b] The symbol ℓ means that the component has been indicated to be present, but the exact concentration is unknown.

TABLE 2. FLUID CATALYTIC CRACKING - FUGITIVE EMISSION CHARACTERIZATION

Stream	% of Unit Fugitives Attributable to that Stream	Weighted Contribution of each Component to Unit Emissions, in ppmw Benzene	Toluene	Ethylbenzene	Xylenes	Other Alkylbenzenes	Naphthalene	Anthracene	Biphenyl	Other Polynuclear Aromatics	n-Hexane	Other Alkanes	Olefins	Cycloalkanes	H_2
Atmos. Gas Oil	1	0	0	0	0	1	0	0	0	2	0	9495	0	500	0
Fuel Gas	30	0	0	0	0	0	0	0	0	0	0	276000	18000	0	6000
LPG Olefins	23	0	0	0	0	0	0	0	0	0	0	92000	138000	0	0
Cracked Naphtha	45	1296	40401	9644	77153	109562	4928			2916	5324	91850	76833	30096	0
Lt. Cycle Gas Oil	1	0	0	0	6	267	590	103	102	6245	0	1906	368	412	0
Hvy. Cycle Gas Oil	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		1296	40401	9644	77159	109830	5518	103	102	9163	5324	471251	233201	31008	6000
	Emiss. Rate lb/hr 59.8	.078	2.42	.577	4.61	6.57	.33	.006	.006	.548	.318	28.18	13.95	1.85	.359

TABLE 3. SUMMARY OF HYDROCARBON SPECIES EMISSIONS FROM FUGITIVE SOURCES

Component	Source							
	V, P, C, F, D, CT*		Relief Valves		API Separators		Totals	
	ppmw	kg/hr	ppmw	kg/hr	ppmw	kg/hr	ppmw	kg/hr
Benzene	7,200	2.8	23,000	0.4	700	0.4	3,900	3.6
Toluene	21,000	8.2	24,000	0.4	2,200	1.1	11,000	9.7
Ethylbenzene	5,600	2.2	4,500	0.1	590	0.3	2,800	2.6
Xylenes	31,000	12.1	26,000	0.4	2,100	1.1	15,000	13.6
Other Alkylbenzenes	42,000	16.6	35,000	0.6	7,900	4.1	23,000	21.3
Naphthalene	1,700	0.7	1,400	0.02	2,900	1.5	2,400	2.2
Anthracene	20	0.01	1	0.0	390	0.2	220	0.2
Biphenyl	230	0.1	110	0.0	1,800	0.9	1,100	1.0
Other PNA's	7,700	3.0	3,300	0.05	1,500	0.8	4,200	3.9
n-Hexane	16,000	6.3	9,700	0.2	i**	i	7,100	6.5
Other Alkanes	654,000	255.9	678,000	11.3	980,000	502.4	840,000	769.6
Olefins	46,000	18.1	30,000	0.5	i	i	20,000	18.6
Cycloalkanes	135,000	52.9	82,000	1.4	i	i	59,000	54.3
Hydrogen	31,000	12.3	82,000	1.4	i	i	15,000	13.7
TOTALS		391.2		16.8		512.8		920.8

* Fugitive emissions from valves, pumps, compressors, flanges, drains, and cooling towers.

** Components marked with "i" are indicated present, but no quantifiable concentration data were available.

PETROLEUM MARKETING

1. The emission factor for benzene was calculated from data in SAI, 1982; Radian, 1985; and CARB, 1984.

   - Total hydrocarbon emissions from petroleum marketing are estimated to be 0.00474 lb/lb gasoline (SAI, 1982).
   - Gasoline density is approximately 7.0 lb/gallon (Radian, 1985).
   - The emissions from gasoline marketing consist of 1.0 weight percent benzene (CARB, 1984).

This yields the following emission factor:

$$\begin{aligned}\text{EF (Benzene)} &= (0.000474\ \text{lb/lb gasoline})\ (7\ \text{lb/gal})\ (.01)\\ &= 3.32 \times 10^{-4}\ \text{lb/gal gasoline}\end{aligned}$$

2. The emission factor for EDB was calculated from data in SAI, 1982; Radian, 1985; and CARB, 1984.

   - Total hydrocarbon emissions from petroleum marketing are estimated to be 0.00474 lb/lb gasoline (SAI, 1982).
   - Gasoline density is approximately 7.0 lb/gallon (Radian, 1985).
   - The emission from gasoline marketing consits of 8.7×10^{-4} weight percent EDB (CARB, 1984).
   - 41.2% of the estimated THC emissions are from leaded gasoline.
   - Allowable lead content for gasoline decreased from 1.1 g/gal to 0.1 g/gal.

   This yields the following emission factor:

$$\begin{aligned}\text{EF (EDB)} &= (0.00474\ \text{lb/lb gasoline})\ (7\ \text{lb/gal})(8.7 \times 10^{-6})(.412)(0.1/1.1)\\ &= 1.08 \times 10^{-8}\end{aligned}$$

3. The emission factor for toluene was calculated from data in SAI, 1982; Radian, 1985; and SAI, 1984.

   - Total hydrocarbon emissions from petroleum marketing are estimated to be 0.00474 lb/lb gasoline (SAI, 1982).
   - Gasoline density is approximately 7.0 lb/gallon (Radian, 1984).
   - The emissions from gasoline marketing consist of 0.66 weight percent toluene (SAI, 1984).

This data yields the following emission factor:

EF (Toluene) = (0.00474 lb/lb gasoline)(7 lb/gal)(.0066)

= 2.19×10^{-4} lb/gal gasoline

EF (Benzene) = (0.000474 lb/lb gasoline)(7 lb/gal)(.01)

= 3.32×10^{-4} lg/gal gaoline

EF (EDB) = (0,99474 lb/lb gasoline)(7 lb/gal)(8.7×10^{-6})

= 2.89×10^{-7} lg/gal gasoline

4. The emission factor for xylene was calculated from data in SAI, 1982; Radian, 1984; and SAI, 1984.

   - Total hydrocarbon emissions from petroleum marketing are estimated to be 0.00474 lb/lb gasoline (SAI, 1982).
   - Gasoline density is approximately 7.0 lb/gallon (Radian, 1985).
   - The emissions from gasoline marketing consist of 0.20 weight percent xylene (SAI, 1984).

   This data yields the following emission factor:

   EF (Xylene) = (0.00474 lb/lb gasoline) (7 lb/gal) (.0020)

   = 6.64×10^{-5} lb/gal gasoline

5. The emission factor for EDC was calculated from data in SAI, 1982, Radian, 1984, and KVB, 1980.

   - The emissions from gasoline marketing consist of 5.7×10^{-3} weight percent EDC (KVB, 1980).
   - 41.2 % of the estimated THC emissions are from leaded gasoline.
   - Allowable lead content for gasoline was decreased from 1.1 g/gal to 0.1 g/gal.

   This data yields the following emission factor:

   EF (EDC) = (0.00474 lb/lb gasoline)(7 lb gal)(5.4×10^{-5})(.412)(0.1/1.1)

   = 7.15×10^{-8} lb/gal gasoline

PORTLAND CEMENT MANUFACTURING

The emission factors for a wet cement grinder are shown below.

1. Chromium

The emission factor for chromium was taken directly from EPA, 1984c. See page 167.

2. Nickel

The emission factor for nickel was taken from a finishing grinding mill after an air separator (EPA, 1984d. See page 128). A fabric filter was used to control emissions. A removal efficiency of 99.8% was used to calculate the uncontrolled EF:

EF = (0.004 lb/100 ton)/0.002

= 0.002 lb/ton of product

PULP AND PAPER MILLS

The emission factor for chloroform emissions from pulp and paper mills was taken from Anderson (1982). Anderson reported several emission factors, based upon product type. Since both mills identified in Alaska produce dissolving sulfite pulp, emission factors for that product were used. Two emission factors were presented by Anderson.

- 0.069 kg CCl_4 per 10^6gm product, emitted during wastewater treatment, and
- 0.0035 kg CCl_4 per 10^6gm product, emitted after wastewater treatment.

To account for total chloroform emissions, the sum of these factors, 0.073 kg CCl_4 per 10^6 gm product (0.146 pound per ton), was used. In these emission factors, the product weight is expressed in terms of air dried product, with a 10 percent moisture content.

RECIPROCATING DIESEL ENGINES AND DIESEL GAS TURBINES

In the Alaska air toxic emission inventory, emission source codes have been established for the following oil combustion sources:

- residual oil (ROC),
- distillate oil (DOC),
- diesel gas turbines (TRB), and
- diesel reciprocating engines (RCP).

Residual and distillate oil are used to fire various boilers in the state. Emission factors for these sources will be taken from the Radian Virginia/San Joaquin emissions inventory. In these two inventories, it was assumed that residual and distillate oil combustion have similar emission factors. Emission factors for diesel engines are presented below.

1. Metals

For the combustion of diesel, the same metals emission factors developed for ROC and DOC will be used. This transfer of data is based on the fact that diesel is analogous to distillate oil. Furthermore, it is reasonable to assume that the metals emissions will be independent of the method of combustion. That is, all trace metals present in the feed will be entrained in the flue gas exiting the combustion unit.

2. PAH

Based on information presented in AP-42, there appears to be significant difference in the amount of VOC and PM emitted by TRB and RCP sources. This indicates there should also be a difference in PAH and formaldehyde emissions. The VOC emission factors for TRB and RCP are shown below:

	VOC	PM	
TRB	4.77	5.00	lbs/1,000 gals burned
RCP	32.10	33.50	lbs/1,000 gals burned

These emission factors suggest that RCP sources will emit greater amounts of PAH than TRB sources.

PAH emission data for diesel engines were obtained from Westerholm, 1986, p. 78. Emissions data are presented for two fuels burned by a 4 stroke diesel engine with no emissions trap. A total of nine data points are available. The average of the reported total hydrocarbon emission factor is 3.4 g/km. The average PAH emission factor is 145 mg/km. We will assume that the RCP engines in Alaska are also 4 stroke engines.

With this information, the fraction of PAH to HC emissions can be calculated:

(145 mg PAH/Km)/(3.4 gm HC/Km) = 4.26 mg PAH/gm HC

(42.6 mg PAH/gm HC)(1 gm/10^6 mg) = 4.26×10^{-5}

A PAH emission factor for TRB and RCP can be calculated as follows:

(4.77 lb/1000 gals)(4.26 $\times 10^{-5}$) = 0.203 lb/10^6 gals

(3.210 lb/1000 gals)(4.26 $\times 10^{-5}$) = 1.37 lb/10^6 gals

The accuracy of these emission factors is highly uncertain. The PAH emission factors for oil combustion are presented below for comparison:

ROC = 0.175 lb/10^6 gals

DOC = 0.175 lb/10^6 gals

TRB = 0.203 lb/10^6 gals

RCP = 1.37 lb/10^6 gals

The resulting emission factors are in pretty good agreement. Although the accuracy is somewhat uncertain, these factors will account for the expected differences in PAH emissions and allow for better risk ranking of sources.

3. Formaldehyde

An emission factor for formaldehyde was developed from data taken from the following document:

U.S. EPA, Emission Characterization of Heavy-Duty Diesel and Gasoline Engines and Vehicles, EPA 460/3-85-001, p. 20.

The following emission factors are presented for a 4 stroke engine:

	mg/kw-hr
Total HC	603
Formaldehyde	19.44

Using these values, the ratio of total HC to formaldehyde is:

$$\frac{19.44}{603} = 0.00322$$

This ratio yields the following formaldehyde emission factors:

$(4.77 \text{ lbs VOC}/1000 \text{ gals})(0.0322) = \underline{0.15 \text{ lb}/10^3 \text{ gals}}$

$(32.10 \text{ lbs VOC}/1000 \text{ gals})(0.0322) = \underline{1.0 \text{ lb}/10^3 \text{ gals}}$

Again, the accuracy of these emission factors is highly uncertain. The formaldehyde emission factors for oil combustion are presented below for comparison:

ROC = 0.033 $\text{lb}/10^3$ gal

DOC = 0.033 $\text{lb}/10^3$ gal

TRB = 0.15 $\text{lb}/10^3$ gal

RCP = 1.0 $\text{lb}/10^3$ gal

RESIDUAL OIL COMBUSTION

Emission factors for residual oil combustion were taken directly from Radian, 1984c. These emission factors are presented under distillate oil combustion.

RESIDENTIAL WOOD COMBUSTION

1. Acetaldehyde

Aldehyde emissions from wood-burning stoves have been reported by DeAngelis et al., (1980) and Alfheim and Ramdahl (1984). DeAngelis et al. reported an acetaldehyde emission factor of 0.1 g/kg for both baffled and nonbaffled stoves. Alfheim and Ramdahl reported emissions of 0.016 g/kg during normal high-temperature burning in an airtight stove, and 0.78 g/kg under starved combustion conditions, which often occur during the night. The value reported by DeAngelis et al. (0.1 g/kg; or 0.2 lb/ton) was used in this inventory.

Acetaldehyde emissions from fireplaces have been measured by Lipari et al. (1984). In an extensive study of aldehyde emissions under varying fuel and combustion conditions, they observed emissions which ranged from 0.08 to 0.20 g/kg, with an average value of 0.117 g/kg (0.234 lb/ton). We have used the average value in calculations of fireplace emissions of acetaldhyde.

2. Benzene

Alfheim and Ramdahl (1984) reported emissions of 0.017 g/kg (0.034 lb/ton) from an airtight stove during normal operation, and 1.3 g/kg (2.6 lb/ton) during starved combustion conditions. The emission factor for normal conditions was used in this inventory.

3. Cresols

Average values of 0.24 g/kg (0.48 lb/ton) and 0.054 g/kg (0.108 lb/ton) were reported by DeAngelis et al., (1980) for cresol emissions from stoves and fireplaces, respectively.

4. Dioxins

The concentration of total chlorinated dioxins in fly ash of wood stoves in the western United States has been reported by Radian (1983). Dioxin concentrations ranging from 4.374 to 10.737 ppb were observed. For the purpose of emission estimation, it was assumed that the dioxin fraction in emitted particulates is equal to that in fly ash, and that the average fly ash dioxin concentration is 7.6 ppb. An average emission factor for particulates of 9.2 g/kg was taken from Butcher and Sorenson (1979). (It should be noted that a wide range of particulate emission factors have been reported by various investigators.) By combining the dioxin fraction with the particulate emission factor, a dioxin emission factor for wood stoves of 69.92 ng/kg (1.40 x 10^{-7} lb/ton) was derived.

5. Formaldehyde

DeAngelis et al. (1980) reported an emission factor of 0.2 g/kg (0.4 lb/ton) for stoves. Alfheim and Ramdahl (1984) reported emissions of 0.05 g/kg during normal high-temperature burning, and 0.99 g/kg during starved combustion conditions. The values reported by DeAngelis et al., were used to estimate emissions.

Formaldehyde emissions from fireplaces were reported by Lipari et al. (1984). Reported values range from 0.09 to 0.71 g/kg, with an average of 0.37 g/kg (0.74 lb/ton). For emission calculations, the average value was used.

6. Metals

Emission factors for metals were reported by DeAngelis et al. (1980) for arsenic, cadmium, chromium, manganese, mercury and nickel. Reported values ranged from 3.6×10^{-5} to 1.7×10^{-3} g/kg (7.2×10^{-5} to 3.4×10^{-3} lb/ton). These values were judged to be insignificant; emission estimates for metals were not developed.

7. Phenol

Average values of 0.16 and 0.023 were reported by DeAngelis et al. (1980) for residential wood stoves and fireplaces, respectively. In a more recent test of several wood stoves for emissions of phenol and POM, Cattone et al. (1985) reported phenol emission factor for fireplaces of 0.050 to 1.10 g/kg, with an average value of 0.302 g/kg.

In calculations of emission estimates, the average value of Cattone et al. (0.302 g/kg; or 0.604 lb/ton) was used for wood stoves, and the value of 0.023 g/kg (0.046 lb/ton), from DeAngelis et al., was used for fireplaces.

8. POM

POM emissions form wood stoves and fireplaces have been reported by several investigators (National Research Council, 1983; Peters et al., 1981; Peters, 1982; DeAngelis et al., 1980; Hall and DeAngelis, 1980; Hartman and Rives, 1985; Snowden, et al., 1975; Lae, et al., 1983; Knight, et al., 1983). Total POM emissions (particulate and gaseous) from wood stoves were reported to range from 0.096 to 451.2 mg/kg. However, it appears that the test methods used to measure the lowest reported emissions may not have effectively measured gaseous POM emissions. If that data set is excluded, the range of reported values is 8.0 to 451.2 mg/kg, with an average value of 211.6 mg/kg (0.423 lb/ton). The average value was used in calculating emission estimates.

The investigators listed above reported that the total POM emissions from residential fireplaces range from 24.9 to 36.5 mg/kg, with an average value of 32.5 mg/kg (0.065 lb/ton). The average value was used in further calculations.

SEWAGE SLUDGE INCINERATION

1. Metals

Metals emissions will be estimated through material balances based on information received in questionnaires.

2. PAH Emissions

To date, the only known PAH emission factors for sewage sludge incineration are contained the following document:

> T. R. Bridle, Assessment of Organic Emissions from the Hamilton Sewage Sludge Incinerator. Environment Canada, Burlington, Ontario, Canada. 1982.

The results of the source test are presented below:

PAH	Run 1 (lb/ton)	Run 2 (lb/ton)	Average (lb/ton)
Acenapthylene	0.00024	0.00032	0.00028
Pyrene	0.00034	0.00050	0.00042
Fluorene	0.00076	0.00082	0.00079
Fluoranthene	—	0.0016	0.0016
Benzo (a) pyrene	0.000004	0.000014	0.000009
TOTAL			0.0031 lb/dry ton

These emission factors are based on the dry weight of sludge. Furthermore, a wet scrubber was used to control emissions and both particulate and gaseous PAH were measured.

3. Dibenzofuran

An emission factor for dibenzofuran can be developed from the same data used to calculate the PAH emission factor listed above. The following emission factors are reported for the two runs: 0.0022 and 0.0026 lb/ton of dry sludge. An average value of 0.0024 lb/dry ton will be used.

SLASH BURNING AND FOREST FIRES

1. POM

Emission factors for POM have been reported by McMahon and Tsoukalas (1978). These factors were reported for vegetation mass loadings ranging from 0.5 kg/m^2 to 2.4 kg/m^2 (0.1 to 0.5 pound per square foot), and for fires advancing both with and against the wind. Total POM emissions reported ranged from 7.63 mg/kg to 171.8 mg/kg (0.153 to 0.344 lb/ton). The average value (0.180 lb/ton) was used to estimate emissions.

2. Manganese

Manganese emission factors were reported by Ward and Hardy (1984). The values reported ranged from 0.2 mg/kg to 9.2 mg/kg (0.0004 to 0.0184 lb/ton). The average value (0.0094 lb/ton) was used to estimate emissions.

WASTE OIL COMBUSTION

1. Metals

According to the ADEC, the following facilities in Alaska burn waste oil:

- Sheldon Jackson College in Sitka -- 150,000 gal/year
- Seward Fisheries -- 150,000 gal/year
- Ft. Wainwright -- 171,000 gal/year
- Alaska DOT & Public Facilities in Fairbanks -- unknown volume

Regulations regarding the combustion of waste oil were promulgated (50 FR 49164) in November of 1985. Boilers and furnaces classified as non-industrial are limited to burning waste oil with the following characteristics.

Metal	Maximum Concentration (ppm)
Arsenic	5
Cadmium	2
Chromium	10
Lead	100

In contrast, a national study of waste oil found the following mean metals concentrations:

Metal	Number of Observations	Mean Concentration (ppm)
Arsenic	1507	4.63
Cadmium	710	1.3
Chromium	721	22.6
Lead	765	706.0

This data was obtained from the following document:

Franklin Associates, Composition and Management of Used Oils Generated in the Unites States, prepared for EPA, November 1985. (PB85 - 180297)

As another point of reference, virgin No. 6 fuel oils has the following metal concentrations:

Metal	Concentration Range of 16 Samples (ppm)
Arsenic	2.0 - 6.1
Cadmium	<1
Chromium	1.0 - 1.6
Lead	1.3 - 9.6
Nickel	12.0 - 68.0

This data was taken from the following source:

> J. Menczel et al., The Regulation of Hazardous and Toxic Substances in Waste Oils Used as Fuels, paper #84-11.1, 77th Annual Meeting of the APCA, June 1984.

For the facilities listed above, the correct metals concentration data must be chosen. The promulgated regulations listed above define industrial boilers as follows:

> "...has been modified from the proposal to define an industrial boiler as any boiler located on site of a manufacturing facility."

Utility boilers are defined as follows:

> "EPA defined utility boilers at proposal as boilers used to produce electric power, steam, heat or cooled air, or other gases of fluids for sale. Owners and operators of utility boilers are burners regulated in the same way as owners and operators of industrial boilers."

Given these regulatory definitions, it appears that none of the major waste oil burners in Alaska are manufacturing facilities or utilities. Consequently, emission factors based on the regulatory limits for non-industrial boilers seem most appropriate. However, emission factors for industrial and non-industrial boilers will be developed for waste oil. The emission factors for metals are presented below.

Non-Industrial Boilers

Metal	Concentration (ppm)	Emission Factor (lb/gal)
Arsenic	5	4.2×10^{-5}
Cadmium	2	1.7×10^{-5}
Chromium	10	8.3×10^{-5}
Lead	100	8.3×10^{-4}

Industrial Boilers

Metal	Concentration (ppm)	Emission Factor (lb/gal)
Arsenic	4.63	3.9×10^{-5}
Cadmium	1.3	1.1×10^{-5}
Chromium	22.6	1.9×10^{-4}
Lead	706	0.0059

Example calculation:

Arsenic emissions for non-industrial boiler burning waste oil =

$$(5 \text{ mg/l})(3.785 \text{ l/gal})(2.2 \text{ lb}/10^{6} \text{ mg}) = (5 \text{ mg/l})(8.33 \times 10^{-6})$$

$$= \underline{4.2 \times 10^{-5} \text{ lb/gal}}$$

The specific gravity of waste oil is typically between 0.9 and 0.95. This slight difference from water was ignored in calculating the emission factors.

As shown above, the major differences between industrial and non-industrial waste oil combustion appear for chromium and lead.

2. Organics

For organics, Franklin Associates report the following concentrations:

Compound		Number of Samples	Mean Concentration (ppm)
1,1,-trichloroethane		236	2013.0
Trichloroethylene		218	471.0
Tetrachloroethylene		215	651.0
PCBs		422	56.7
Benzene		38	80.5
Toluene		47	1711.0
Xylene		40	6510.0
Benz (a)-anthracene	PAH	27	66.7
Benz (a)-pyrene		66	

A certain portion of these organics will be destroyed in the boiler. At the same time, other air toxics will be formed as products of incomplete combustion. A 99.99% destruction and removal efficiency is certainly achievable for these organic compounds in large boilers. Applying a 4-9 DRE to xylene would give the following emission factor:

$$(6510 \text{ mg/L})(3.785 \text{ L/gal})(2.2\text{x}10^{-6} \text{ lb/mg})(1-0.9999)$$

$$= 5.4 \text{ x } 10^{-6} \text{ lb/gal}$$

A facility burning 150,000 gallons per year would thus emit 0.81 lbs/yr of xylene. This emission rate is considered insignificant. Therefore, with the exception of PAH and formaldehyde organic emissions from waste oil combustion will be ignored. PAH and formaldehyde emission factors will be transferred from residual oil combustion since waste oil closely resembles No. 6 fuel oil.

WOOD COMBUSTION

1. PAH

Emission factors for wood combustion were taken from the following document:

> Tennessee Valley Authority. Wood-fired Boiler Test Report - Stick Burner. TVA Report No. TVA/OP/ECR-84/4. Energy Use Test Facility, Chattanooga, Tennessee, August 1983.

The emission for this source test were uncontrolled. The fuel used in the tests was white oak and mixed logs. The following POM emission factors are available:

65 mg/kg
83 mg/kg
87 mg/kg

Average = 78 mg/kg
= 0.16 lb/ton

This emission factor represents both particulate and gaseous POM. It will be assumed that POM equals PAH in this case.

2. Aldehydes

Formaldehyde and acetaldehyde emissions are expected from industrial wood combustion; however, an emission factor is not available. The aldehyde emission factors for residential wood combustion could be transferred. But the combustion characteristics of a fireplace are expected to be very disimilar to a boiler.

3. Metals

Emission factors for metals are not available.

APPENDIX C

AREA SOURCE EMISSION ESTIMATES

ASPHALT DISTRIBUTION AND USAGE

Activity data for asphalt distribution and usage were obtained from the Department of Energy's Energy Data Reports: Sales of Ashpalt in 1980.

This data is presented in the attached Table C-1. The total mass of for each type of asphalt was apportioned to the major cities based on population.

TABLE C-1.

ASPHALT USE IN ALASKA, 1980

(Units in Tons)

Asphalt Type	Alaska	Anchorage	Fairbanks	Juneau	Ketchikan	Sitka
Asphalt Cement	55,911	24,265	7,492	2,740	1,455	1,062
Cutback Asphalt	3,302	1,433	442	162	92	63
Emulsified Asphalt	8,497	3,688	1,139	416	238	161
Road Oils	196	85	26	10	6	4

RESIDENTIAL WOOD COMBUSTION

Emission factors were calculated for several pollutants produced by residential wood combustion (see Appendix B). These emission factors are specific to either wood stoves or fireplaces. In addition, some of the values apply only to normal or to starved combustion conditions. All emission factors are expressed in terms of mass pollutant per kilogram or ton of wood burned.

In order to calculate emission estimates, the following additional information is required:

- the total amount of wood burned in fireplaces and in stoves, and
- the breakdown between day and night fuel use (it is assumed that daytime burning corresponds to normal combustion conditions, while overnight burning corresponds to starved combustion conditions).

This information was obtained form wood use surveys and from U.S. census data.

The derivation of the activity estimates used and the calculation of emission estimates are described below.

Activity Data

Estimates of the extent of wood use in Anchorage, Fairbanks, and Juneau were derived from wood use surveys conducted in 1984 and 1985 by the Environmental Services Division (ESD) of Fairbanks North Star Borough and the Anchorage Air Pollution Control Agency, as well as one survey of wood use in the Mendenhall Valley (Juneau). The Juneau survey results were assumed to apply to Sitka and Ketchikan as well.

The survey results are shown in Table C-2. In order to estimate the total wood use in stoves and fireplaces, these results were combined with U.S. Department of Commerce census data on the number of households in each city. The census data are displayed in Table C-3.

Estimates of the total amount of wood burned in fireplaces in each city were calculated using the following equation:

$$\text{Total Wood Burned in Fireplaces} = \text{Total Number Number of Households} \times \text{Fraction of Households Using Wood}$$

$$\times \text{Fraction of Wood-burning Households with Fireplaces} \times \text{Average amount of Wood Burned Fireplaces}$$

TABLE C-2.

WOOD USE SURVEY RESULTS

CITY:	Fairbanks	Anchorage	Juneau
Parameter			
Households using Wood (percent of all households)	51	63.3	56.1
Device Type (percent of wood-burning households)			
Fireplace	24.0	92.1	25.0
Stove	68.0	7.9	73.5
Other	7.9	0.0	1.5
Amount of Wood Burned (cords/year, average)	2.8	0.35	2.95[a] 0.62[b]
Time of Day Wood Burned (percent of wood-burning households)			
Day	12.7	NR[c]	NR
Night	53.7	NR	NR
Continuous	28.6	NR	NR

a) Wood stove consumption

b) Fireplace consumption

c) Not reported

TABLE C-3.

NUMBER OF OCCUPIED YEAR-ROUND HOUSING UNITS FOR FIVE ALASKA BOROUGHS - 1980

Boroughs	Total Occupied Year-Round Housing Units
Anchorage	60,470
Fairbanks North Star	18,224
Juneau	7,035
Ketchikan	3,985
Sitka	2,440

Example calculation - wood use rate - Fairbanks - fireplaces

$$\text{Total Wood Burned} = \text{Number of Households} \times \text{Fraction Using Wood} \times \text{Fraction of Wood Users w/Fireplaces} \times \text{Average Amount of Wood Burned w/Fireplaces}$$

1. Number of households = 18,224 (See Table C-3).

2. Fraction using wood = 0.51 (See Table C-2).

3. Fraction of wood-uses with fireplaces = 0.24 (See Table C-2).

4. Average amount of wood burned in fireplaces.

   - Assume ratio of (amount used in average stove) = (Amount used in average fireplace) is the same as that reported for Juneau = $\frac{2.95}{0.62}$

   - In Fairbanks, 24% of respondents used fireplaces; 76% used stoves or "other"

   - Average (overall) in Fairbanks was 2.8 cord/year

   Let x = average amount used in fireplaces.

   Then $\frac{2.95}{0.62}x = 4.76x$ = average amount used in stoves

   Overall average $2.8 \frac{\text{cord}}{\text{year}} = 0.24x + 0.76(4.76x)$

   $\Rightarrow x = 0.72$ = average amount used in fireplaces
   $4.76x = 3.43$ = average amount used in stoves

5. Total Wood Burned

   $= (18{,}224 \text{ households})(0.51/\text{house})(0.24)(0.72 \frac{\text{cords}}{\text{year}}) = 1606$ cords/year

   $(1606 \text{ cord/yr.})(2100 \text{ kg/cord}) = 3.37 \times 10^6$ kg/yr.

Example calculation - POM emissions - Fairbanks - fireplaces

(Emissions) = (Fireplaces wood use) (POM emissions factor-fireplaces)

$= (3.37 \times 10^6 \text{ kg/yr})(0.033 \text{ g/kg}) = 1.1121 \times 10^5$ g/yr

= 111 kg/year.

A similar equation was used to estimate wood stove fuel use. In the case of Fairbanks, the estimates were further refined to estimate daytime and nighttime wood use. Based on the information shown in Table C-2, the values calculated using equation (1) were multiplied by 0.32 to determine daytime use, and by 0.68 to determine nighttime use. These values were derived by apportionating the continuously operated wood buners to daytime use and nighttime use. The continuously operated wood burners were assumed to operate under daytime conditions two-thirds of the time and under nighttime conditions one-third of the time.

Separate wood use estimates for stoves and fireplaces were not available for Fairbanks and Anchorage. The relative use rates for fireplaces and stoves were assumed to be the same in Fairbanks as in Juneau (fireplace use: stove use = 0.210). The ADEC indicated that the average wood use in Anchorage should be applied to woodstoves and fireplaces. Thus the following wood use values were used:

City	Device	Average Wood Use
Fairbanks	Fireplaces	0.72 cords/year
	Stoves	3.43 cords/year
Anchorage	Fireplaces	0.35 cords/year
	Stoves	0.35 cords/year

Finally, a factor of 4,600 lb/cord was used to convert wood volume to mass. An example calculation, using the data for fireplaces in Fairbanks, is included at the end of this Appendix.

Emission Calculation

The activity data, in units of kg wood burned, were combined with the emission factors described in Appendix B to calculate estimated pollutant emissions. A sample calculation, for POM emissions from wood stoves in Fairbanks, is included at the end of this Appendix.

Total emissions from stoves, fireplaces and "other" devices were summed; it was assumed that stove emission factors applied to the "other" category as well. Tables C-4 and C-5 contain summaries of these analyses. Table C-4 presents the wood usage rates which were used to calculate emissions. The emission estimates derived using these values are show in Table C-5.

TABLE C-4.

SUMMARY OF ESTIMATED RESIDENTIAL WOOD COMBUSTION RATES

	Wood Use (lb/yr)	
Borough	Stove[a]	Fireplace
Anchorage	4.9×10^6	5.6×10^7
Fairbanks North Star	1.1×10^8	7.4×10^7
Juneau	4.1×10^7	2.9×10^6
Ketchikan	2.4×10^8	1.6×10^6
Sitka	1.5×10^8	1.0×10^6

a) Stove wood combustion includes wood burned in unknown devices.

b) The recent popularity of wood stoves and the growth in the number of housing units in Anchorage since 1980 may result in an underestimation of the number of wood stoves and the amount of wood burned.

TABLE C-5.

SUMMARY OF ESTIMATED POLLUTANT EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION

	Estimated Emission Rate (lb/yr)				
Pollutant	Anchorage[b]	Fairbanks North Star	Juneau	Ketchikan	Sitka
Acetaldehyde	490	11,000	4,400	2,500	1,500
Benzene[a]	3,000	1,900	690	390	240
Cresols	1,200	27,000	9,900	5,600	3,400
Dioxins[a]	0.00034	0.0078	0.0022	0.0012	0.00076
Formaldehyde	970	22,000	9,200	5,200	3,200
Phenol -	1,500	34,000	12,000	7,000	4,300
POM	1,000	24,000	9,000	4,900	3,000

a) Emission estimates for these species only include the contributions from wood-burning stoves - emission factors for fireplaces were not available.

b) The recent popularity of wood stoves and the growth in the number of housing units in Anchorage since 1980 may result since an underestimation of the number of wood stoves and the amount of wood burned.

SLASH BURNING AND FOREST FIRES

Activity Data

Information on slash burning conducted in the Fairbanks and Anchorage areas was obtained from ADEC staff. These estimates were based upon permit data:

Fairbanks Area -	200 acres/year
Anchorage Area -	
Kenai Peninsula -	1,100 acres/year
Matanuska-Susitna Valley -	9,000 acres/year
Total -	10,100 acres/year

(These estimates do not take into account proposed projects. Several projects involving slash burning have been proposed; if carried out, they could account for more slash burning than the current estimated total.) Information on the extent of slash burning projects in Southeast Alaska was not readily available and was not obtained. Similarly, information on the acreage burned by forest fires was not readily available and was not obtained. However, it is expected that the amount of vegetation consumed by forest fires could be equal to or greater than that burned by planned fires in some areas.

Emission Calculations

Emissions were calculated using the emission factors for POMs and manganese documented in Appendix B. Those emission factors are related to mass of vegetation burned. The values of acreage burned, described above, were converted to mass values using mass loadings identified in a Kenai National Wildlife Refuge Memorandum (1986) to the ADEC. The more conservative value of 8 tons/acre was used for the conversions.

Total emissions calculated in this way are displayed in Table C-6.

TABLE C-6.

POM AND MANGANESE EMISSIONS FROM SLASH BURNING

Area	Emission Rate (lb/year)	
	POMs	Manganese
Fairbanks	290	15
Anchorage		
Kenai Peninsula	1,600	83
Matanuska-Susitna Valley	13,000	680

APPENDIX D

SURFACE COATING VOC SPECIATION DATA

CES PROFILE NUMBER 712
INDUSTRIAL SURFACE COATING - COMPOSITE ENAMEL

SAROAD CODE	CHEMICAL NAME	WEIGHT PERCENT
43232	HEPTANE	1.56
43248	CYCLOHEXANE	2.27
43551	ACETONE	5.57
43552	METHYL ETHYL KETONE	2.36
43560	METHYL ISOBUTYL KETONE	1.57
43433	ETHYL ACETATE	8.96
45202	TOLUENE	15.90
43435	N-BUTYL ACETATE	9.41
45203	ETHYLBENZENE	2.36
45102	ISOMERS OF XYLENE	11.56
45204	0-XYLENE	11.53
50075	C5 ESTER	5.51
50077	HEPTANONE	3.62
50076	2-METHYL-3-HEXANONE	16.44
45104	ISOMERS OF ETHYLTOLUENE	0.88
45107	ISOMERS OF TRIMETHYLBENZENE	0.50
	TOTAL	100.00

CES PROFILE NUMBER 713
INDUSTRIAL SURFACE COATING - COMPOSITE PRIMER

SARCOAD CODE	CHEMICAL NAME	WEIGHT PERCENT
43232	HEPTANE	1.94
43261	METHYLCYCLOHEXANE	2.50
45202	TOLUENE	44.30
43108	ISOMERS OF NONANE	3.45
50059	DIMETHYLCYCLOHEXANE	6.26
43277	2,4-DIMETHYLHEXANE	11.09
43435	N-BUTYL ACETATE	8.42
50091	DIMETHYLHEPTANE	1.04
50061	ETHYLCYCLOHEXANE	2.08
50060	TRIMETHYLCYCLOHEXANE	2.43
45102	ISOMERS OF XYLENE	1.45
45204	0-XYLENE	2.23
43271	2,4-DIMETHYLPENTANE	2.66
50074	BUTYL CELLOSOLVE	10.13
	TOTAL	99.98

CES PROFILE NUMBER 714
INDUSTRIAL SURFACE COATING - COMPOSITE ADHESIVE

SAROAD CODE	CHEMICAL NAME	WEIGHT PERCENT
43551	ACETONE	13.28
43231	HEXANE	0.90
43122	ISOMERS OF PENTANE	56.03
43552	METHYL ETHYL KETONE	11.17
43262	METHYLCYCLOPENTANE	3.22
50080	BUTANDIOL	11.17
43560	METHYL ISOBUTYL KETONE	0.80
45202	TOLUENE	3.42
	TOTAL	99.99

CES PROFILE NUMBER 711
INDUSTRIAL SURFACE COATING - COMPOSITE LACQUER

SAROAD CODE	CHEMICAL NAME	WEIGHT PERCENT
43232	HEPTANE	10.16
43261	METHYLCYCLOHEXANE	15.24
43277	2,4-DIMETHYLHEXANE	0.76
50057	ETHYLCYCLOPENTANE	1.68
50058	TRIMETHYLCYCLOPENTANE	1.29
50090	METHYLHEPTENE	1.14
45202	TOLUENE	44.56
43108	ISOMERS OF NONANE	2.04
43107	ISOMERS OF OCTANE	2.39
43435	N-BUTYL ACETATE	14.89
43288	ETHYLCYCLOHEXANE	0.79
50060	TRIMETHYLCYCLOHEXANE	0.81
45102	ISOMERS OF XYLENE	1.04
45204	O-XYLENE	3.14
	TOTAL	99.93

APPENDIX E

DETAILED LISTING OF POINT SOURCE RANKING

HEALTH RISK RANKING BY EMISSION SOURCE

FACILITY/LOCATION	RANKING FACTOR	EMISSION SOURCE
NORTH SLOPE BOROUGH-NORTH SLOPE	480712	MUNICIPAL INCINERATION-MC
CHANNEL LANDFILL-JUNEAU	450871	MUNICIPAL INCINERATION-MC
CITY OF SITKA-SITKA	118027	MUNICIPAL INCINERATION-MC
KETCHIKAN PULPCO-KETCHIKAN	84000	WOOD COMBUSTION
ALYESKA PIPELINE PUMP STATION #11-COPPER CENTER	41483	TURBINE DIESEL ENG
ALYESKA PIPELINE PUMP STATION #10-BLACK RAPIDS	39774	TURBINE DIESEL ENG
ALYESKA PIPELINE PUMP STATION #7-LIVENGOOD	37761	TURBINE DIESEL ENG
ALYESKA PIPELINE PUMP STATION #8-FAIRBANKS	37351	TURBINE DIESEL ENG
ALYESKA PIPELINE PUMP STATION #9-DELTA	33943	TURBINE DIESEL ENG
ALYESKA PIPELINE PUMP STATION #6-YUKON RIVER	33920	TURBINE DIESEL ENG
ALASKA PULP CORP-SITKA	33600	WOOD COMBUSTION
HACOR-ANCHORAGE	32897	MUNICIPAL INCINERATION-SC
US ARMY FT. WAINWRIGHT-FAIRBANKS	30481	COAL COMBUSTION
USAF SHEMYA AFB-SHEMYA	29110	MUNICIPAL INCINERATION-SC
WRANGELL FOREST PRODUCTS-WRANGELL	28000	WOOD COMBUSTION
US NAVY ADAK NAVAL AIR STN-ADAK	25008	DISTILLATE OIL COMBUSTION
ALYESKA PIPELINE PUMP STATION #5-PROSPECT	18914	TURBINE DIESEL ENG
CITY OF WHITIER-WHITIER	9862	MUNICIPAL INCINERATION-SC
ALYESKA PIPELINE/PUMP STATION' #3-SAGAVANIRTOK	8678	MUNICIPAL INCINERATION-SC
USAF KING SALMON AFB-	8408	MUNICIPAL INCINERATION-SC
ALYESKA MARINE TERMINAL-VALDEZ	7552	TURBINE DIESEL ENG
KODIAK ELECTRIC ASSN-KODIAK ISLAND	7136	RECIPROCATING DIESEL ENG
GOLDEN VALLEY E ASSN-HEALY	6217	COAL COMBUSTION
US ARMY FT WAINWRIGHT-FAIRBANKS	5870	DISTILLATE OIL COMBUSTION
US COAST GUARD-KODIAK	5449	DISTILLATE OIL COMBUSTION
US NAVY SECURITY GROUP ACTIVITY-ADAK	5095	DISTILLATE OIL COMBUSTION
KETCHIKAN PUBLIC UTILITY-KETCHIKAN	4343	RECIPROCATING DIESEL ENG
USAF SHEMYA AFB-SHEMYA	4128	DISTILLATE OIL COMBUSTION
ALASKA PULP CORP-SITKA	4046	DISTILLATE OIL COMBUSTION
UNOCAL CHEMICAL DIVISION-KENAI PENINSULA	3866	WASTE OIL COMBUSTION
US ARMY FT GREELEY-DELTA	3722	DISTILLATE OIL COMBUSTION
BETHEL UTIL CORP-BETHEL	3067	RECIPROCATING DIESEL ENG
GOLDEN VALLEY E ASSN FAIRBANKS	3037	TURBINE DIESEL ENG
GOLDEN VALLEY E ASSN-FAIRBANKS	2769	RECIPROCATING DIESEL ENG
USAF EIELSON AFB-FAIRBANKS	2450	COAL COMBUSTION
NOME JOINT UTILITIES-NOME	2389	RECIPROCATING DIESEL ENG
CORDOVA ELEC COOP, INC-CORDOVA	2180	RECIPROCATING DIESEL ENG
TESORO-ALASKAN-KENAI PENINSULA	2091	GASOLINE EVAPORATION
US ARMY FT RICHARDSON-ANCHORAGE	2033	DISTILLATE OIL COMBUSTION
KOTZEBUE ELEC ASSN-KOBUK	1905	RECIPROCATING DIESEL ENG
ALASKA ELEC L&P-JUNEAU	1881	RECIPROCATING DIESEL ENG
MITKOF LUMBER CO-WRANGELL	1796	WOOD COMBUSTION
NAKNEK ELEC-BRISTOL BAY	1760	RECIPROCATING DIESEL ENG
PETERSBURG MUNI LIGHT & PWR-PETERSBURG	1663	RECIPROCATING DIESEL ENG
UNIVERSITY OF ALASKA-FAIRBANKS	1648	COAL COMBUSTION
WRANGELL LIGHT & POWER-WRANGELL	1501	RECIPROCATING DIESEL ENG
NUSHAGAK ELEC COOP-BRISTOL BAY	1388	RECIPROCATING DIESEL ENG
USAF CAPE NENENHAM AFS-PLATINUM	1373	DISTILLATE OIL COMBUSTION
PACIFIC FORESET PRODUCTS-HAINES	1368	WOOD COMBUSTION
US ARMY FT WAINWRIGHT-FAIRBANKS	1245	WASTE OIL COMBUSTION
ICICLE SEAFOODS-SEWARD	1165	WASTE OIL COMBUSTION
SHELDON JACKSON COLLEGE-SITKA	1165	WASTE OIL COMBUSTION
AK VILLAGE ELECTRIC CO-OP-MT VILLAGE	1109	RECIPROCATING DIESEL ENG
HAINES LIGHT & POWER-HAINES	1082	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-SELAWIK	871	RECIPROCATING DIESEL ENG
ALASKA HUSKY BATTERY INC-ANCHORAGE	867	BATTERY MANUFACTURING
AK VILLAGE ELECTRIC CO-OP-NUNAPITCHUK	844	RECIPROCATING DIESEL ENG

HEALTH RISK RANKING BY EMISSION SOURCE

FACILITY/LOCATION	RANKING FACTOR	EMISSION SOURCE
AK VILLAGE ELECTRIC CO-OP-NOORVIK	839	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-KIANA	833	RECIPROCATING DIESEL ENG
UNOCAL/GRAYLING-COOK INLET	823	RECIPROCATING DIESEL ENG
SHELL/C-COOK INLET	823	RECIPROCATING DIESEL ENG
ATLANTIC RICHFIELD CO-BARROW	800	WOOD COMBUSTION
AK VILLAGE ELECTRIC CO-OP-SHISHMAREF	799	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-TOGIAK	799	RECIPROCATING DIESEL ENG
AMOCO/BRUCE-COOK INLET	791	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-GAMBELL	754	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-NOATAK	704	RECIPROCATING DIESEL ENG
MAPCO PETROLEUM CORP-NORTH POLE	701	RECIPROCATING DIESEL ENG
ALASKA PULP CORP-SITKA	672	WASTE WATER EMISSIONS
AK VILLAGE ELECTRIC CO-OP-NULATO	636	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-SHUNGNAK	634	RECIPROCATING DIESEL ENG
KETCHIKAN PULPCO-KETCHIKAN	590	WASTE WATER EMISSIONS
ANCHORAGE WATER AND SEWER-ANCHORAGE	553	SLUDGE INCINERATION
UNOCAL CHEMICAL DIVISION-KENAI PENINSULA	520	COOLING TOWERS
STANDARD ALASKA PROD CO-BARROW	513	RECIPROCATING DIESEL ENG
DOT THE AK RAILROAD-FAIRBANKS	483	COAL COMBUSTION
FAI N S BOROUGH SCHOOL DIST-FAIRBANKS	476	DISTILLATE OIL COMBUSTION
AK VILLAGE ELECTRIC CO-OP-KIVALINA	474	RECIPROCATING DIESEL ENG
US COAST GUARD-KODIAK	466	WASTE OIL COMBUSTION
STANDARD ALASKA PRODUCTION CO-BARROW	463	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-STEBBINS	450	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-AMBLER	443	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-FORTUNA LEDGE	440	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-TOK SOOK BAY	440	RECIPROCATING DIESEL ENG
ALYESKA/PUMP STATION #3-SAGAVANIRTOK	439	TURBINE DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-EEK	438	RECIPROCATING DIESEL ENG
COOK INLET PIPELINE-KENAI PENINSULA	430	RESIDUAL OIL COMBUSTION
SKAGWAY POWER & TELEPHONE-SKAGWAY	407	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-HOLY CROSS	407	RECIPROCATING DIESEL ENG
COPPER VALLEY E ASSN-VALDEZ,GLENNALLEN	404	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-OLD HARBOR	402	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-KATAG	389	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-KOYUK	382	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-GOODNEWS BAY	376	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-GRAYLING	376	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-ELIM	362	RECIPROCATING DIESEL ENG
ANCHORAGE INTERNATIONAL-ANCHORAGE	347	AIRPORTS
AK VILLAGE ELECTRIC CO-OP-NEW STUYAHOK	335	RECIPROCATING DIESEL ENG
TESORO PETROLEUM CORP-KENAI PENINSULA	276	COMPLEX REFINERY FUGITIVES
ARCO/KING SALMON-COOK INLET	274	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-WALES	274	RECIPROCATING DIESEL ENG
AK GOLD CO-NOME	271	RECIPROCATING DIESEL ENG
FAI N S BOROUGH SCHOOL DIST-FAIRBANKS	271	DISTILLATE OIL COMBUSTION
AK VILLAGE ELECTRIC CO-OP-MINTO	260	RECIPROCATING DIESEL ENG
AMOCO/BAKER-COOK INLET	242	RECIPROCATING DIESEL ENG
AK VILLAGE ELECTRIC CO-OP-SHAYELUK	232	RECIPROCATING DIESEL ENG
ALYESKA PIPELINE PUMP STATION #11-COPPER CENTER	209	DISTILLATE OIL COMBUSTION
WRANGELL FOREST PRODUCTS-WRANGELL	202	RECIPROCATING DIESEL ENG
PROVIDENCE HOSPITAL-ANCHORAGE	202	ETHYLENE OXIDE STERILIZERS
ALYESKA/PUMP STATION #1-DEADHORSE	187	TURBINE DIESEL ENG
UNOCAL/GRANITE POINT COOK INLET	161	RECIPROCATING DIESEL ENG
GOLDEN VALLEY E ASSN-YUKON	161	RECIPROCATING DIESEL ENG
TESORO ALASKAN-ANCHORAGE	161	GASOLINE EVAPORATION

HEALTH RISK RANKING BY EMISSION SOURCE

FACILITY/LOCATION	RANKING FACTOR	EMISSION SOURCE
FAIRBANKS MEMORIAL HOSPITAL-FAIRBANKS	154	ETHYLENE OXIDE STERILIZERS
HUMANA HOSPITAL ANCHORAGE	134	ETHYLENE OXIDE STERILIZERS
SNOW WHITE LDY & CLNRS ANCHORAGE	131	PCE DRY CLEANING
ALASKA NATIVE MEDICAL CENTER-ANCHORAGE	115	ETHYLENE OXIDE STERILIZERS
ALASKA ELECTROPLATING & BUMPER REP.-ANCHORAGE	114	CHROME PLATING-DECORATIVE
ALYESKA PIPELINE PUMP STATION #7-LIVENGOOD	114	DISTILLATE OIL COMBUSTION
CHEVRON USA INC-ANCHORAGE	107	GASOLINE EVAPORATION
BARTLETT MEMORIAL HOSPITAL-JUNEAU	94	ETHYLENE OXIDE STERILIZERS
ALYESKA PIPELINE PUMP STATION #8-FAIRBANKS	84	DISTILLATE OIL COMBUSTION
ALYESKA/PUMP STATION #4-ATIGUN RIVER	82	TURBINE DIESEL ENG
ALYESKA/PUMP STATION #2-SAGWON	82	TURBINE DIESEL ENG
TEXACO ANCHORAGE	68	GASOLINE EVAPORATION
ANCHORAGE SAND & GRAVEL-ANCHORAGE	65	HOT MIX ASPHALT PRODUCTION
ROGERS & BABLER-ANCHORAGE	65	HOT MIX ASPHALT PRODUCTION
FAIRBANKS INTERNATIONAL-FAIRBANKS	64	AIRPORTS
PHILLIPS PETROLEUM-KENAI	58	COOLING TOWERS
USAF REGIONAL HOSPITAL-ELMENDORF AFB	50	ETHYLENE OXIDE STERILIZERS
KETCHIKAN GENERAL HOSPITAL-KETCHIKAN	50	ETHYLENE OXIDE STERILIZERS
VALLEY HOSPITAL-PALMER	47	ETHYLENE OXIDE STERILIZERS
CHEVRON USA INC-VALDEZ,CHITINA,WHITTIER	44	GASOLINE EVAPORATION
US NAVY ADAK NAVAL AIR STN-ADAK	40	GASOLINE EVAPORATION
PETROLEUM DIRECTORATE-WHITTIER	35	GASOLINE EVAPORATION
WILDER CONSTRUCTION CO-ANCHORAGE	33	HOT MIX ASPHALT PRODUCTION
ENGINE GEER CO., INC-ANCHORAGE	32	ELECTROPLATING-CHROMIUM
ROGERS & BABLER-FAIRBANKS	30	HOT MIX ASPHALT PRODUCTION
HARLEY'S TRUCKING-SOLDOTINA	30	HOT MIX ASPHALT PRODUCTION
WILDER CONSTRUCTION CO-ANCHORAGE	29	HOT MIX ASPHALT PRODUCTION
ROGERS & BABLER-ANCHORAGE	26	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC-FAIRBANKS	25	GASOLINE EVAPORATION
CENTRAL PENINSULA HOSPITAL-SOLDOTNA	25	ETHYLENE OXIDE STERILIZERS
JUNEAU AIRPORT-JUNEAU	24	AIRPORTS
ASSOCIATED SAND & GRAVEL #14-PTBURG,KETCH,SITKA	24	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC CORDOVA	24	PCE DRY CLEANING
PETROLEUM DIRECTORATE-ANCHORAGE	23	GASOLINE EVAPORATION
M-B CONTRACTING CO-ANCHORAGE	19	HOT MIX ASPHALT PRODUCTION
DEAD HORSE AIRPORT-DEADHORSE	17	AIRPORTS
QUALITY ASPHALT PAVING-ANCHORAGE	17	HOT MIX ASPHALT PRODUCTION
MUNICIPAL UTILITIES SYS FAIRBANKS	17	COAL COMBUSTION
CHEVRON USA INC-JUNEAU	17	GASOLINE EVAPORATION
AMOCO PRODUCTION CO-KENAI PENINSULA	16	RECIPROCATING DIESEL ENG
KETCHIKAN INTERNATIONAL-KETCHIKAN	16	AIRPORTS
ASSOCIATED ASPHALT PAVING-ANCHORAGE	16	HOT MIX ASPHALT PRODUCTION
BASSETT ARMY HOSPITAL-FT WAINWRIGHT	16	ETHYLENE OXIDE STERILIZERS
MAPCO PETROLEUM CORP-NORTH POLE	15	TOPPING REFINERY FUGITIVES
CHEVRON USA INC-NOME	15	GASOLINE EVAPORATION
TRANS-ALASKA CONSTRUCTION-FAIRBANKS	14	HOT MIX ASPHALT PRODUCTION
ARCTIC ENERGY-FOX	13	TOPPING REFINERY FUGITIVES
ALYESKA PIPELINE/PUMP STATION #10-BLACK RAPIDS	13	TOPPING REFINERY FUGITIVES
ALYESKA PIPELINE/PUMP STATION #8-FAIRBANKS	13	TOPPING REFINERY FUGITIVES
SITKA AIRPORT-SITKA	11	AIRPORTS
PAVING PRODUCTS-FAIRBANKS	11	HOT MIX ASPHALT PRODUCTION
PAVING PRODUCTS INC-FAIRBANKS	11	RECIPROCATING DIESEL ENG
CHEVRON USA INC-SKAGWAY	11	GASOLINE EVAPORATION
CHEVRON USA INC-ALEUTIAN ISLANDS	11	GASOLINE EVAPORATION
ROGERS & BABLER-ANCHORAGE	10	HOT MIX ASPHALT PRODUCTION
CENTRAL PAVING/RED SAMM-ANCHORAGE	9	HOT MIX ASPHALT PRODUCTION

HEALTH RISK RANKING BY EMISSION SOURCE

FACILITY/LOCATION	RANKING FACTOR	EMISSION SOURCE
TEXACO-FAIRBANKS	9	GASOLINE EVAPORATION
EARTHMOVERS OF FAIRBANKS-ANCHORAGE	8	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC-KOBUK	8	GASOLINE EVAPORATION
RASCO INC FAIRBANKS	7	HOT MIX ASPHALT PRODUCTION
EARTHMOVERS OF FAIRBANKS FAIRBANKS	7	HOT MIX ASPHALT PRODUCTION
BRIDGEWATER-FAIRBANKS	7	HOT MIX ASPHALT PRODUCTION
PETRO STAR INC.-NORTH POLE	6	TOPPING REFINERY FUGITIVES
CHEVRON USA-KENAI PENINSULA	6	TOPPING REFINERY FUGITIVES
ARCO-PRUDHOE BAY	6	TOPPING REFINERY FUGITIVES
ARCO-KUPARUK	6	TOPPING REFINERY FUGITIVES
ASSOCIATED SAND & GRAVEL #15-JUNEAU	6	HOT MIX ASPHALT PRODUCTION
ALASKA BASIC INDUSTRIES-ANCHORAGE	6	CEMENT GRINDER-WET PROCESS
VALLEY ASPHALT CO-PALMER	6	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC-BRISTOL BAY	6	GASOLINE EVAPORATION
CHEVRON USA INC-KENAI PENINSULA	6	GASOLINE EVAPORATION
CHEVRON USA INC-KETCHIKAN	6	GASOLINE EVAPORATION
CHEVRON USA INC-KODIAK ISLAND	6	GASOLINE EVAPORATION
WILDER CONSTRUCTION-ANCHORAGE	5	HOT MIX ASPHALT PRODUCTION
MUNICIPAL UTILITIES SYS-FAIRBANKS	5	TURBINE DIESEL ENG
KNIK CONSTRUCTION-LYNDEN	4	HOT MIX ASPHALT PRODUCTION
GERS & BABLER-ANCHORAGE	4	HOT MIX ASPHALT PRODUCTION
US ARMY FT WAINWRIGHT-FAIRBANKS	4	GASOLINE EVAPORATION
ASSOCIATED SAND & GRAVEL #3-KETCHIKAN	3	HOT MIX ASPHALT PRODUCTION
BRECHAN ENTERPRISE-KODIAK	3	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC-CORDOVA	3	GASOLINE EVAPORATION
EARTHMOVERS OF FAIRBANKS FAIRBANKS	2	HOT MIX ASPHALT PRODUCTION
CHEVRON USA INC-UPPER YUKON	2	GASOLINE EVAPORATION
ROGERS & BABLER-ANCHORAGE	1	HOT MIX ASPHALT PRODUCTION
TRANS ALASKA CONSTRUCTION-EAGLE RIVER	1	HOT MIX ASPHALT PRODUCTION
WILSON CONSTRUCTION-CORDOVA	0	HOT MIX ASPHALT PRODUCTION
AA MECHANICAL-ANCHORAGE	0	ELECTROPLATING-CHROMIUM
SHOVELHEAD HYDRAULICS-FAIRBANKS	0	ELECTROPLATING-CHROMIUM
PARKER PAVING CORP-ANCHORAGE	0	HOT MIX ASPHALT PRODUCTION
WEL-ASKA CORP-VALDEZ	0	HOT MIX ASPHALT PRODUCTION
RED SAMM-JUNEAU	0	HOT MIX ASPHALT PRODUCTION
RASMUSSEN'S CO-ANCHORAGE	0	HOT MIX ASPHALT PRODUCTION
TESORO ALASKAN-KENAI PENINSULA	0	COOLING TOWERS
ALASKAN PAINT MANUFACTURING CO. INC-ANCHORAGE	0	PAINT MANUFACTURING
GREAT LANDS SEAFOOD-UNALASKA	0	WASTE OIL COMBUSTION
CITY OF KODIAK FISH PROCESSING PLNT-	0	WASTE OIL COMBUSTION
ANCHORAGE LIGHT AND POWER-ANCHORAGE	0	COOLING TOWERS
USAF EIELSON AFB-FAIRBANKS	0	AIRPORTS
ALASKA DOT-FAIRBANKS	0	WASTE OIL COMBUSTION
UNOCAL FAIRBANKS	0	GASOLINE EVAPORATION
US NAVY ADAK NAVAL AIR STATION-ADAK	0	FREON DRY CLEANING
USAF ELMENDORF AFB-ANCHORAGE	0	AIRPORTS
FAI COMMUNITY HOSPITAL-FAIRBANKS	0	PATHOLOGICAL INCINERATION

APPENDIX F

AIR TOXICS QUESTIONNAIRES

STATE OF ALASKA
DEPT. OF ENVIRONMENTAL CONSERVATION

BILL SHEFFIELD, GOVERNOR

DIVISION OF ENVIRONMENTAL QUALITY
P.O. BOX O, JUNEAU, AK 99811-1800

(907) 465-2666

July 18, 1986

Dear Sir or Madame:

Public concern about exposure to toxic substances has prompted the U.S. Environmental Protection Agency to develop a national strategy for controlling routine emissions of toxic air contaminants. This strategy includes a directive to states to examine their own needs for controlling and regulating emissions of toxic air contaminants. In response to this directive, the Alaska Department of Environmental Conservation is conducting an inventory of toxic air contaminants and volatile organic compounds which may be emitted into Alaska's air.

As part of this inventory, the Department requests that you complete the attached questionnaires for operators of facilities which handle or have the potential to emit toxic substances in Alaska. The number and type of questionnaires mailed were based on a general classification of your facility. If some of the forms or specific questions do not apply or no information is available, please indicate this in your response. Your cooperation in completing the questionnaires as comprehensively as possible will be appreciated. If necessary, please make copies of forms in order to provide information on all activities at your facility.

Radian Corporation has been contracted to identify the potential sources of toxic air contaminants, prepare questionnaires and compile quantitative emission estimates. Return all completed forms no later than August 15, 1986, to Mr. Ronald Dickson, Radian Corporation, 10395 Old Placerville Road, Sacramento, CA 95827.

Please clearly and specifically identify any information you would consider confidential and give a brief explanation for this designation. Information identified as confidential will be treated as such by the Department and contractor personnel.

General questions regarding the inventory purpose and process can be directed to Mr. Jon Sandstedt at (907) 465-2666. Technical questions regarding proper completion of the forms or emission estimation procedures may be directed to Mr. Ronald Dickson of the Radian Corporation at (916) 362-5332.

Sincerely,

Leonard D. Verrelli

Leonard D. Verrelli
Air Quality Program Manager

LV:clb

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

AIR TOXICS QUESTIONNAIRE

Facility Name: ______________________________

____

Address: ______________________________

____

____

Individual to be contacted with questions regarding this form:

Name: ______________________________

Title: ______________________________

Phone Number: ______________________________

* Emission Source: ______________________________

---

* To be completed by ADEC

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

INDUSTRIAL INCINERATION QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information and data on the emission of air toxics from the incineration of industrial wastes.

Equipment Specification

This section is intended to gather general process information about the incinerator. Please describe the type of incinerator used, e.g., dual chamber fixed hearth. Also prepare a block diagram that shows the flow of material into and out of the incinerator. This block diagram is intended to be a material balance of the operation.

Waste Characteristics

Please complete this section for each waste incinerated. Make multiple copies of this section as necessary. Question 3 should be completed after reviewing Table 1. Any constituents from Table 1 that are incinerated should be recorded under Question 3.

Residual Characteristics

Residual characteristics will be used with the information gathered in the previous section to perform a material balance. Please provide all available information that will be useful.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

INDUSTRIAL INCINERATION QUESTIONNAIRE

EQUIPMENT SPECIFICATION

1. Please provide a block diagram of the incinerator showing the feed equipment, incinerator, ash handling equipment, and air pollution control equipment. This diagram should show all material entering and leaving the system.

2. Type of incinerator: ______________________________

3. Operating schedule: _____ hr/day _____ day/wk _____ wk/yr

4. Operating temperature: __________ °F

5. Type of auxiliary fuel used: ______________________________

   Quantity of auxiliary fuel used: ______________________________

6. Incinerator dimensions: ______________________________

7. Flue gas flow rate: ______________ CFM (dry basis, standard conditions)

8. Air pollution control equipment:

Control Device	Pollutant Controlled	Efficiency[1]	Basis for Efficiency[2]

---

[1] Efficiency should be expressed on a weight removal basis.

[2] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

WASTE CHARACTERISTICS

1. Waste[1] type # _____ : ____

2. Quantity of waste: # _____ incinerated: ____________________________

3. If available, please provide data on the constituents listed in Table 1 that are present in the waste:

Constituent	Concentration (ppm)	Basis for Concentration Estimate[2]

---

[1] Use a separate sheet for each type of waste incinerated. Number each waste consecutively starting with 1.

[2] Describe the basis for the estimate (i.e., analytical tests, safety data sheets, etc.).

RESIDUAL CHARACTERISTICS

1. Mass of particulate emitted from the incinerator: ______________ lbs/hr

2. Mass of volatile organic compounds emitted from the incinerator: ______ lbs/hr

3. If available, please provide information on the constituents listed in Table 1 that are present as particulate:

Constituent	Stack Gas Concentration[1]	Basis for Concentration Estimate[2]

4. If available, please provide information on the constituents listed in Table 1 that exit the incinerator as gases or vapors:

Constituent	Stack Gas Concentration[1]	Basis for Concentration Estimate[2]

5. Mass of Ash generated by incinerator: ______________________ lbs/hr

---

[1] Express concentration as milligrams per dry standard cubic feet per minute.

[2] Describe the basis for the estimate (i.e., source tests, material balances, etc.).

6. Constituents listed in Table 1 that are present in the ash:

Constituent	Ash Concentration (ppm)	Basis for Concentration Estimate[1]

---

[1] Describe the basis for the estimate (i.e., source tests, material balances, etc.).

TABLE 1. FIFTY-SIX SELECTED NONCRITERIA POLLUTANTS

Acetaldehyde
Acrolein
Acrylonitrile
Allyl chloride
Arsenic
Asbestos
Benzene
Benzidine
Benzyl chloride
Berryllium
Bis(chloromethyl)ether
Cadmium
Carbon tetrachloride
CFC 113 (Freon 113)
Chlorobenzene
Chloroform
Chloroprene
Chromium
Cresols
Dibromoethane (Ethylene dibromide)
1,4-Dichlorobenzene
3,3-Dichlorobenzidine
Dichloroethane (Ethylene dichloride)
Dichloromethane (Methylene chloride)
Dimethyl sulfate
Dioxane
Dioxins
Epichlorohydrin
Ethyleneimine (Aziridine)
Ethylene oxide
Formaldehyde
Hexachlorocyclopentadiene
Hydrazine
Lead arsenate
Maleic anhydride
Manganese
Mercury
B-Napthylamine
Nickel
Nitrobenzene
N-Nitrosodimethylamine
Nitrosomorpholine
Parathion
Phenol
Phosgene
Polychlorinated biphenyls (PCBs)
Polycyclic Organic Matter (includes Benzo(a)pyrene)
Propylene oxide
Radionuclides
Tetrachloroethylene (Perchloroethylene)
Toluene
1,1,1-Trichloroethane (Methyl chloroform)
Trichloroethylene
Vinyl chloride
Vinylidene chloride
Xylene

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SEWAGE SLUDGE INCINERATION QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information and data on the emission of toxic metals from the incineration of municipal sewage sludge.

Equipment Specification

This section is intended to gather general process information about the incinerator. Please describe the type of incinerator used, e.g., multiple hearth, fluidized bed. Also prepare a block diagram that shows the flow of material into and out of the incinerator. This block diagram is intended to be a material balance of the operation.

Waste Characteristics

In Question 1, please indicate the type and concentration of metal wastes that are received at the sewage treatment plant. This information will help prepare a material balance around the incinerator.

Residual Characteristics

Residual characteristics will be used with the information gathered in the previous section to perform a material balance of heavy metals.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SEWAGE SLUDGE INCINERATION QUESTIONNAIRE

EQUIPMENT SPECIFICATION

1. Please provide a block diagram of the incinerator showing the feed equipment, incinerator, ash handling equipment, and air pollution control equipment. This diagram should show all material entering and leaving the system.

2. Type of incinerator: ______________________________

____

____

3. Operating schedule: _____ hr/day _____ day/wk _____ wk/yr

4. Operating temperature of primary chamber: __________ °F

Operating temperature of secondary chamber: __________ °F

5. Type of auxiliary fuel used: ____________________

Quantity of auxiliary fuel used: ____________________

6. Incinerator dimensions: ______________________________

7. Flue gas flow rate: ________________CFM (dry basis, standard conditions)

8. Air pollution control equipment:

Control Device	Pollutant Controlled	Efficiency[1]	Basis for Efficiency[2]

---

[1] Efficiency should be expressed on a weight removal basis.

[2] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

WASTE CHARACTERISTICS

1. If available, please provide information on the metals content of the treatment system influent:

METAL	CONCENTRATION (ppm)
Arsenic	
Berryllium	
Cadmium	
Chromium	
Lead	
Manganese	
Mercury	
Nickel	

2. If available, please provide the metals concentration of the incinerator feed (PPM, dry basis):

	SLUDGE	SCUM	OTHER WASTES
ARSENIC			
BERRYLLIUM			
CADMIUM			
CHROMIUM			
LEAD			
MANGANESE			
MERCURY			
NICKEL			

3. Moisture content of sludge: _______%

4. Mass of sludge incinerated: ________ lbs/day ________ lbs/yr

5. Mass of scum incinerated: __________ lbs/day _________ lbs/yr

6. Quantity of other wastes incinerated: ________ lbs/day _______ lbs/yr

Types of other wastes: ________________________________

____

____

RESIDUAL CHARACTERISTICS

1. Mass of ash generated: __________ lb/hr _____________ lb/yr

2. If available, please provide the metals content of the ash:

METAL	CONCENTRATION (ppm)
Arsenic	
Berryllium	
Cadmium	
Chromium	
Lead	
Manganese	
Mercury	
Nickel	

3. If available, please provide the mass of particulate emitted from the incinerator:

_________ lb/hr _________ lb/yr

4. If available, please provide the mass of volatile organic compounds emitted from the incinerator:

_________ lb/hr _________ lb/yr

5. If available, please provide the mass of metal constituents emitted from the incinerator:

METAL	LB/HR	BASIS FOR EMISSION RATE[1]
Arsenic		
Berryllium		
Cadmium		
Chromium		
Lead		
Manganese		
Mercury		
Nickel		

---

[1] Describe the basis for the emission rae (i.e., source tests, material balances, etc.).

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ELECTROPLATING QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information and data on the emission of chromium, nickel, and cadmium from electroplating operations.

General Information

The first page of the questionnaire is designed to identify the type(s) of electroplating in use. Please complete this page as accurately as possible.

Operating Characteristics

Please complete this section separately for each tank in use. Three copies of this section are provided. If there are more than three tanks in use, please make additional copies as necessary.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ELECTROPLATING QUESTIONNAIRE

GENERAL INFORMATION

1. Is chrome plating performed at this facility? ______ Yes ______ No

If yes, what type of plating is performed?

Decorative __________

Hard Plating __________

Chromic Acid Anodizing __________

2. Is nickel plating performed at this facility? ______ Yes ______ No

3. Is cadmium plating performed at this facility? ______ Yes ______ No

TANK OPERATING CHARACTERISTICS[1]

Type of plating operation: ______________________________.[2]

Plating Tank #: ____________________ (1, 2, 3, etc.).[3]

Operating Schedule: ____________ Hr/day __________ day/yr

Surface area of plating tank: ___________ square feet

Typical range of total current: ______________ ampres.

Type of pollution control equipment: __________________________

__________________________.

Estimated control efficiency: ______________________________[4]

Basis for removal efficiency: ______________________________

______________________________.[5]

---

[1] Complete this page separately for each electroplating tank in use. Make additional copies of this page if necessary.

[2] Please use the descriptors provided under the general information section on the previous page.

[3] Please number each tank in use starting with the #1.

[4] Efficiency should be expressed on a weight removal basis.

[5] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ETHYLENE OXIDE STERILIZATION QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information that can be used to estimate emissions of ethylene oxide from hospital sterilization activities.

General Instructions

In order to accurately estimate ethylene oxide emissions from your hospital, we need information relating to the entire hospital (questions 1 and 2) as well as specific information on each ethylene oxide sterilizer used (questions 3 through 11). Please make and fill out a separate copy of questions 3 through 11 for each ethylene oxide sterilizer at your hospital.

RADIAN
CORPORATION

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

ETHYLENE OXIDE STERILIZATION QUESTIONNAIRE

1. Is ethylene oxide used as a sterilant at your hospital? ____ Yes ____ No

If ethylene oxide is not used, please answer question 1(a) and return this questionnaire. If ethylene oxide is used, please answer the remaining questions.

1 (a). Is material from you hospital sterilized with ethylene oxide at a contract sterilization facility? _____ Yes _____ No

If yes, please name the facility which does your ethylene oxide sterilization: ______________________________

____

2. How many beds are there in your hospital (approximately)? ____________

3. As compared to other hospitals, do any conditions exist at your hospital which may lead to a higher or lower than average use of materials sterilized with ethylene oxide (such as an above average amount of surgery)?

______ Yes ______ No

If yes, please explain: ______________________________

____

____

____

If more than one ethylene oxide sterilizer is used at your hospital, please make a separate copy of the remaining questions for each sterilizer used.

4. Sterilizer number: __________ (1, 2, 3...)
type: __________ (table-top)
__________ (built-in)

5. Sterilizer manufacturer and model: ______________________________
____

6. Sterilizer volume: ________________ Cubic feet: ________________

7. Average number of sterilization cycles per day (approximate): __________

8. Type of sterilant gas mixture used:

__________ 12% ethylene oxide and 88% freon-12 by weight
__________ 100% ethylene oxide
__________ 10% ethylene oxide and 90% carbon dioxide by weight
__________ other. Please indicate the sterilant gas mixture used:
____

9. Size of container sterilant gas is received in:

__________ 70 lb net weight cylinder
__________ 75 lb net weight cylinder
__________ 160 lb net weight cylinder
__________ 67 gram cartridge (3M Sterigas® 2-67)
__________ 100 gram cartridge (3M Sterigas® 4-100)
__________ 134 gram cartridge (3M Sterigas® 4-134)
__________ other. Please indicate size: ________________________

10. Please indicate the number of sterilant containers used:

monthly: __________, and

annually: __________.

11. Is a non-recirculating water-sealed pump used to evacuate the sterilization chamber?

__________ (yes/no)

If no, please describe the type of pump used for sterilization chamber evacuation: ______________________________

____

____

12. Are any emission control devices used to reduce ethylene oxide emissions to the outdoor air?

__________ (yes/no)

If yes, please indicate the type and efficiency of control:

__________ scrubber

__________ catalytic filter

__________ carbon adsorption columns

__________ other. Please describe the control device used: ______

____

Efficiency[1]: __________%

Basis for Efficiency[2]: ______________________________

---

[1] Efficiencies should be expressed on a weight removal basis.

[2] Describe the basis for the efficiency estimate (i.e., source test, vendor guarantee, etc.).

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PAINT MANUFACTURING SURVEY

1. Please provide as an attachment, a block diagram of the paint manufacturing process showing materials storage equipment, feed equipment, mixing tanks, and all air pollution control devices. This diagram should show all materials entering and leaving the system.

2. Operating mode: Batch __________ or Continuous __________

3. Operating schedule: __________ hr/day __________ day/wk __________ wk/yr

   or: __________ hrs/batch __________ batches/yr

4. Please complete Table 1 for each pigment used by the facility.

5. Please complete Table 2 for each solvent used as a paint additive.

6. Please complete Table 3 for each solvent used in tank cleaning operations.

7. Describe tank cleaning procedures: ______________________________

   ____

   ____

   ____

   ____

   ____

   ____

8. List the quantity of waste generated from tank cleaning and describe the treatment/disposal practices for this waste: ______________________

   ____

   ____

   ____

   ____

   ____

   ____

9. Please provide the following information for each air pollution control device used at the facility:

Control Device	Pollutant Controlled	Efficiency[1]	Basis for Efficency[2]

---

[1] Efficiencies should be reported in terms of weight percent removal of the pollutant controlled.

[2] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

TABLE 1. PIGMENT USE INFOMATION

PIGMENT NAME	PIGMENT COMPOSITION[1]	PIGMENT USE[2] LBS/DAY	LBS/YR	FUGITIVE DUST EMISSION LOSSES[3]

---

[1] By weight percent, list the major constituents of the pigment.

[2] List the daily and annual pigment use for the facility.

[3] As a percentage of the total pigment use, estimate fugitive dust emission losses that occur during the handling of the dry pigment.

TABLE 2. SOLVENT ADDITIVE INFORMATION

SOLVENT NAME	SOLVENT COMPOSITION[1]	SOLVENT USE[2]		SOLVENT EVAPORATIVE LOSSES (%)[3]	MIXING TEMPERATURE (°F)[4]	PAINT PRODUCTION[5]		SOLVENT CONTENT OF PAINT[6] (WEIGHT %)
		LBS/DAY	LBS/YR			LBS/DAY	LBS/YR	

---

[1] By weight percent, list the major constituents of the solvent.

[2] List the daily and annual solvent use for the facility.

[3] As a percentage of the total solvent use, estimate solvent losses due to evaporation.

[4] List the mixing temperature used during solvent addition.

[5] List the daily and annual paint production associated with the solvent.

[6] If available, please list the weight percent of solvent contained in the paint.

TABLE 3. CLEANING SOLVENT USE INFORMATION

SOLVENT NAME	SOLVENT COMPOSITION[1]	SOLVENT USE[2]		SOLVENT EVAPORATIVE LOSSES (%)[3]
		LBS/DAY	LBS/YEAR	

---

[1] By weight percent, list the major constituents of the solvent.

[2] List the daily and annual solvent use for the facility.

[3] As a percentage of the total solvent use, estimate solvent losses due to evaporation.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

LEAD BATTERY MANUFACTURING QUESTIONNAIRE

GENERAL INFORMATION

1. List the types of batteries manufactured at this facility:

   Automotive: __________ Industrial: __________

   Other (describe): ____________________________

2. Provide the following production data for each battery type listed in Question 1:

   Automotive battery production: __________ Batteries/Year __________ Batteries/Day

   Industrial battery production: __________ Batteries/Year __________ Batteries/Day

   Other battery production: _______________ Batteries/Year __________ Batteries/Day

3. List the average or typical lead content for each battery type:

   Automotive batteries: _____________ lb. lead/battery

   Industrial batteries: _____________ lb. lead/battery

   Other batteries: __________________ lb. lead/battery

   Note: Lead content refers to the total quantity of lead in the battery including elemental lead in battery grids and terminals, and lead compounds in the active material of battery plates.

4. List the percent of each battery type manufactured using open formation and closed formation processes:

   Automotive batteries: ______% Open Formation ______% Closed Formation

   Industrial batteries: ______% Open Formation ______% Closed Formation

   Other batteries: ___________% Open Formation ______% Closed Formation

PROCESS INFORMATION

A. GRID CASTING

1. For each battery type, list the percent lead and the percent of alloying metals contained in the battery grids:

Automotive batteries: ______% Lead

______% ______________ (List metal)

______% ______________ (List metal)

Industrial batteries: ______% Lead

______% ______________ (List metal)

______% ______________ (List metal)

Other batteries: ______% Lead

______% ______________ (List metal)

______% ______________ (List metal)

B. LEAD OXIDE PRODUCTION

1. Is lead oxide produced on-site? _____ Yes _____ No

2. For on-site lead oxide production, identify the process used to produce the lead oxide :

Barton ______________________________ Ball Mill ______________________________

Other ____

____

3. If fabric filters are used to control air emissions from on-site lead oxide production, list the air to cloth ratio (4:1, 3:1, or 2:1) of the filter:

Air to cloth ratio: ____

C. LEAD RECLAIM

1. Is a lead reclaim furnace used at this facility? _____ Yes _____ No

2. If a lead reclaim furnace is used, approximately what percent of the total lead processed at the facility is reclaimed in the furnace? _____%

D. FORMATION

1. Provide the following information for closed formation processes:

Automotive batteries: Length of charging cycle _____ Hours

Charging rate _____ Amps

Industrial batteries: Length of charging cycle _____ Hours

Charging Rate _____ Amps

Other batteries: Length of charging cycle _____ Hours

Charging cycle _____ Amps

E. AIR POLLUTION CONTROL EQUIPMENT

1. Provide the following information for each air pollution control device used at the facility:

Control Device	Process[1] Controlled	Pollutant Controlled	Efficiency[2]	Basis for Efficiency[3]

---

[1] Process controlled refers to manufacturing processes such as grid casting, posting, formation, etc.

[2] Report efficiency in weight percent removal of controlled parameter.

[3] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

COOLING TOWER QUESTIONNAIRE

1. Is a cooling tower (or towers) used at this facility? ____ Yes ____ No

If a cooling tower (or towers) is not used, complete only question one and return this questionnaire. If a cooling tower is used, please answer the remaining questions.

2. What type of cooling tower(s) is used?

_____ Mechanical draft evaporative cooling tower

_____ Natural draft evaporative cooling tower

_____ Other, please describe: ____

____

____

____

3. In the space provided below, please list the chemical additives used the cooling tower. If known, also record the quantity of each chemical used and/or its concentration in the cooling water.

Chemical Additive	Amount Used (lb/yr)	Concentration in the Cooling Water (ppm)

4. If a cooling tower is used in conjunction with electrical power generation, what is the thermal energy input to the power plant:

____________________________ BTU/hr

5. What is the volume of cooling water used? ____________________ gallons/hr

6. Is the cooling water recycled? _____ Yes _____ No

If yes, how much cooling water is removed through blowndown?

_______ gallons/hr

What is the quantity of water recycled? ______________ gallons/hr

7. If known, please indicate the quantity of cooling tower drift as a percent of the cooling water used:

______ %

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SURFACE COATING QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information and data on the emission of air toxics from the application of paints, varnishes, and other surface coating materials.

Operation Description

Please provide a written description of the surface coating operation. For example, the description should indicate whether brushing, rolling, spraying, flow coating, or dipping operations are used.

Separate copies of the questionnaire should be completed for each surface coating operation in use.

Coating Material Characteristics

Only broad categories of surface coating materials are listed in the questionnaire due to limited speciation data of volatile organic compounds from surface coating. Please categorize your coating material within these classifications as appropriate.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SURFACE COATING QUESTIONNAIRE

OPERATION DESCRIPTION

1. Is surface coating used at this facility? ____________ Yes ____________ No

2. If yes, please briefly describe the surface coating operation: ____________

____

____

____

____

____

____

3. Operating schedule: _______ hr/day _________ day/wk _______ wk/yr

4. Are any air pollution control devices used to control volatile emissions?

_____ Yes _____ No

If yes, what control devices are used?

CONTROL DEVICE	POLLUTANT CONTROLLED	EFFICIENCY[1]	BASIS FOR EFFICIENCY[2]

---

[1] Efficiency should be expressed on a weight removal basis.

[2] Describe the basis for estimating efficiency (i.e., source test, vendor guaranty, etc.).

COATING MATERIAL CHARACTERISTICS

1. Please provide the coating application rate for the following materials:

COATING MATERIAL	VOLUME USED (gal/yr)	BASE[1]
Lacquer		
Enamel		
Primer		
Adhesive		
Water base paint		
Oil base paint		

2. Are powder coatings used at your facility? _____ Yes _____ No

If yes, please indicate which coating materials are powders:

COATING MATERIAL	QUANTITY USED (lb/yr)

SOLVENT USAGE

1. Are makeup solvents added to coatings to compensate for standing losses?

_____ Yes _____ No

---

[1] Where appropriate, indicate whether the coating material is water or oil based.

If yes, list the solvent compounds used and their volumes:

SOLVENT	VOLUME USED (gal/yr)

2. Are any solvents used for facility and equipment cleanup?

______ Yes ______ No

If yes, list the solvent compounds used and their volumes:

SOLVENT	VOLUME USED (gal/yr)

3. Please describe the treatment/disposal practices for this waste: ________

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DEGREASING QUESTIONNAIRE

PREFACE

Purpose

The purpose of this questionnaire is to gather information and data on the emission of air toxics from degreasing operations.

Operation Description

This section is intended to gather general information about the degreasing operation. Please describe the types of degreasers and solvents used and the total volume of each solvent purchased in 1985.

Spent Solvent Disposition

Please copy this section and complete it for each degreasing operation in use.

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DEGREASING QUESTIONNAIRE

OPERATION DESCRIPTION

1. Is degreasing performed at this facility? _____ Yes _____ No

2. If yes, please indicate the type of degreasing unit used:

	IN USE?	SOLVENTS USED
Cold cleaner		
Open top vapor		
Conveyorized, vapor		
Conveyorized, non-boiling		

3. For each degreasing operation, record the volume of solvent purchased for 1985:

DEGREASING OPERATION	TYPE OF SOLVENT USED	VOLUME OF SOLVENT PURCHASED (GAL/YR)

SPENT SOLVENT DISPOSITION[1]

1. Degreasing Operation: ______________________________

2. Is spent solvent generated? ________ Yes ________ No

3. If spent solvent is generated, is the solvent shipped off-site for disposal? _______ Yes _______ No

   If yes, how much solvent is shipped off-site? _______ lbs/yr

   What percent of the spent solvent is actually solvent? ______ %

   Please append any analytical data that documents the composition of the spent solvent.

4. Is spent solvent reclaimed on-site? _______ Yes _______ No

   If yes, how much solvent is reclaimed? __________ lbs/yr

   If yes, how much sludge is generated from the reclaiming operation? _________ lb/yr

   Please append any analytical data that documents the compositon of the reclaimed solvent and still bottoms.

---

[1] Please complete this section separately for each degreasing operation in use.

APPENDIX G

EMISSION SOURCE CATEGORIES ASSOCIATED WITH SELECTED NON-CRITERIA POLLUTANTS

APPENDIX G

EMISSION SOURCE CATEGORIES ASSOCIATED WITH SELECTED NON-CRITERIA POLLUTANTS

EMISSION SOURCE CATEGORIES ASSOCIATED WITH SELECTED NONCRITERIA POLLUTANTS

Pollutants	Identified Emissions Sources[1]	References
Acetaldehyde	Acetic acid production Pentaerythritol production Peracetic acid production Pyridenes manufacturing Acetaldehyde production Glyoxal production	SAI, 1982
Acrolein	Production of refined acrolein and glycerin Methionine analogs (poultry feed supplements) production Production of acrylic acid intermediate	SAI, 1982 Sittig, 1981
Acrylonitrile	Acrylonitrile production Acrylic, modacrylic fiber production Production of ABS and SAN resins Nitrile rubber and latex production Adiponitrile production Acrylamide production Production of nitrile barrier resins	Radian, 1983c Tierney, 1979a U.S. EPA, 1982B
Allyl chloride	Production of allyl chloride, epichlorohydrin, and glycerin (usually at the same plant)	SAI, 1982
Arsenic	End-use in pesticide, herbicides, and fungicides Primary copper and zinc smelting Glass manufacturing Coal combustion Primary and secondary lead smelting Production of chemicals containing arsenic (including insecticides, herbicides, and wood preservatives) Sewage sludge incinerators Gray iron foundry	Archer, 1979a Crecelius, 1974 Enterline, 1976 Gerstle, 1982 Radian, 1982 Sittig, 1981

Pollutants	Identified Emissions Sources[1]	References
Asbestos	Mining and milling of asbestos	Archer, 1979b
	Production of asbestos-containing products (including brake linings, shingles and siding, textiles, paper and felt, floor tile, and cement pipe and sheet)	Sittig, 1981
	Installation of asbestos construction materials	
	Roadway surfacing	
	Building demolition and renovation	
Benzene	Automobile exhaust	
	Gasoline evaporation	
	Benzene production	
	Production of ethylbenzene, styrene, phenol, cyclohexane, maleic anhydride, aniline, chlorobenzenes, nitrobenzene, ethylene, and linear alkyl benzene	
	Solvent usage in textile manufacturing, degreasing, organic synthesis, pharmaceutical synthesis, aluminum alkyls, alchohols, and consumer products	
	Coke production/coke ovens	
Benzidine	Benzidines production	Archer, 1979c
	Production of commercial dyes (primarily azo, mordant, and direct dyes)	Walker, 1978c
	Manufacturing of rubber chemicals	
	End-use of dyes (mainly in textiles, paper, and leather industries)	
Benzyl Chloride	Benzyl chloride production	SAI, 1982
	Butyl benzyl phthalate production	
	Quaternary ammonium compounds production	
	Benzyl alcohol production	
Berryllium	Coal combustion	Sittig, 1975
	Oil combustion	SAI, 1982
	Gray iron foundry	Rancitelli, 1974
	Beryllium metal and alloy production	
	Coke production/coke ovens	

Pollutants	Identified Emissions Sources[1]	References
(continued)	Waste incineration Cement production Ceramic plants Rocket motor firings	
Bis(chloromethyl) ether	Anion-exchange resin production Textile manufacturing (segment using formaldehyde-containing reactants and resins in fabric finishing and as adhesives) Nonwoven industry (using thermosetting acrylic emulsion polymers)	Fishbein, 1979a Rohlack, Updated
Cadmium	Primary cadmium smelting Primary zinc and copper smelting Iron and steel manufacturing Secondary copper smelting Primary lead smelting Coal combustion Waste and sewage sludge incineration Production of cadmium paint pigments Production of cadmium-barium plastic stabilizers Ni-Cd battery manufacturing Cement production	Gerstle, 1982 Rancitelli, 1974 Sittig, 1975
Carbon tetrachloride	Miscellaneous solvent applications (as an oil, wax, and fat extractant; in rubber cement; in shoe and furniture polishes; in paints and lacquers; in printing ink; in floor waxes, and in stains) Carbon tetrachloride production Fluorocarbon gas production (F-11 and F-12) Miscellaneous uses (pharmaceuticals manufacturing, pesticide formulation, carbon tetrabromide manufacturing, chlorine production)	Anderson, 1983b SAI, 1982 U.S. EPA, 1982a

Pollutants	Identified Emissions Sources[1]	References
CFC 113 (Freon 113)	Critical cleaning of electrical and mechanical assemblies Solvent applications (primarily degreasing, cleaning and drying) Solder flux removal Dry cleaning	U.S. EPA, 1983
Chlorobenzene	End-use as degreasing solvent (cold cleaners) and intermediate in pesticides manufacturing Chlorobenzene production Nitrochlorobenzene production	SAI, 1982
Chloroform	Miscellaneous solvent end-uses (manufacturing of artificial silk, plastics, floor polishes, fluorocarbons, dyes, pesticides) Evaporation from pulp/paper bleaching wastewater Pharmaceuticals production Chloroform production EDC production Cooling towers F-22 production	Anderson, 1982b Fishbein, 1979a Kelly, undated Sittig, 1981 SAI, 1982
Chloroprene	Chloroprene production and captive use in polychloroprene synthetic rubber manufacturing (neoprene, duprene)	SAI, 1982 Sittig, 1981
Chromium	Steel production Ferrochromium production Coal combustion Chromium chemicals production (primarily sodium chromate and sodium dichromate) Refractory production Oil combustion Waste and sewage sludge incineration Cement production Cooling towers Electroplating	Gerstle, 1982 Kelly, undated Radian, 1983b

Pollutants	Identified Emissions Sources[1]	References
Cresols[3]	End-use as wire enamel solvent End-uses as disinfectant/cleaning compound, and ore flotation agent Coke production/coke ovens Cresol production Cresylic acid production Phenolic resins production Miscellaneous production (BHT, antioxidants, pesticides, tricresyl phosphate)	SAI, 1982
Dibromoethane (Ethylene dibromide)	Evaporation of leaded automotive fuel End-use as soil and grain fumigant	Sittig, 1981
1,4-Dichlorobenzene (p-Dichlorobenzene)	End-uses as space deodorant and for moth control 1,4-Dichlorobenzene production Pesticide production (as an intermediate) Finishing of woven fabrics	McCurley, 1980 SAI, 1982
3,3-Dichlorobenzidine	None documented[2]	
Dichloroethane (Ethylene dichloride)	Methyl chloroform production Dichloroethane production Ethyl chloride production Ethyleneamines production Vinylidene chloride production Trichloroethylene production Vinyl chloride production Evaporation of leaded automotive fuel End-use as an extraction solvent (animal fats, pharmaceuticals) End-use as a cleaning solvent (plastics, textiles, apparel)	Anderson, 1983a GCA, 1976b SAI, 1982
Dichloromethane (Methylene chloride)	Formulation and use of household paint and varnish removers End-use as a metal degreasing solvent (primarily cold cleaners) Aerosol vapor depressant Plastics processing	Sittig, 1981 SAI, 1982

Pollutants	Identified Emissions Sources[1]	References
(continued)	Intermediate in dye and pharmaceutical production Extraction solvent for soils, fats, and waxes	
Dimethyl sulfate	Manufacturing of methyl esters, ethers and amines, dyes, drugs, perfume, phenol derivatives, and pesticides Solvent in the separation of mineral oils	Sittig, 1981
Dioxane	Solvent for cellulose acetate, dyes, fats greases, lacquers, mineral oil, paints polyvinyl polymers, resins, varnishes and waxes Paint and varnish stripping Wetting/dispersing agent in textile processing dye baths, and stain and printing compositions	Sittig, 1981
Dioxins	Hazardous and municipal waste incinerators, wire reclamation incinerators, industrial boilers wood stoves, fire-places, residential furnaces, forest fires, transformer fires, charcoal production and internal combustion engines End-use of pentachlorophenol (wood preservative) Production of pentachlorophenol trichlorophenol and 2,4,5-T (herbicide)	Radian, 1983a SAI, 1982
Epichlorohydrin	Epoxy resin production Epichlorohydrin and glycerin production Production of miscellaneous epichlorohydrin products (polyamide-epichlorohydrin resins, epichlorohydrin elastomers, and surfactants)	Kelly, undated Smith, 1983a SAI, 1982
Ethyleneimine (Aziridine)	Textile industry (used in flameproofing, shrink-proofing, stiffening, and waterproofing)	Sittig, 1981
Ethylene oxide	Ethylene oxide production Production of ehtylene glycol, di-, tri-, and poly-ethylene glycol, surface active agents, and ethanolamines	Sittig, 1981 Smith, 1983b

Pollutants	Identified Emissions Sources[1]	References
Formaldehyde	Production of urea, phenolic, and melamine resins Production of pentaerythritol, butanediol, acetal resins, and hexamethylenetetramine Formaldehyde production Resin applications (primarily in construction materials industries) End-use in textile (textile treating), paper, and coatings industries Fuel combustion Catalytic cracking (refineries)	Kelly, 1983 Misenheimer, 1983 SAI, 1982 U.S. EPA, 1984
Hexachlorocyclopentadiene	Hexachlorocyclopentadiene production Manufacturing of flame retardants, pesticides, and flame-retardant resins	SAI, 1982
Hydrazine	Used in chemical synthesis (anticorrosives, dyes, textile agents, pesticides, pharmaceuticals) Used as a rocket fuel	Sittig, 1981 Stedman, 1977
Lead arsenate	Manufacturing formulation, and application of lead arsenate insecticide	Sittig, 1981
Maleic anhydride	Maleic anhydride production Production of phtalic anhydride and unsaturated polyester resins	GCA, 1976d
Manganese	Ferromanganese and silicomanganese production Iron and steel production Gray iron foundry Coal combustion Coke production/coke ovens Chemical applications and battery production Solid waste and sewage incineration Cooling towers Oil combustion	Gerstle, 1982 Kelly, undated Sittig, 1975 SAI, 1982

Pollutants	Identified Emissions Sources[1]	References
Mercury	Mercury mining and processing Chloralkali manufacturing Coal combustion Copper and zinc smelting Paint application Incineration Coke production/coke ovens	Gerstle, 1982 Sittig, 1975
B-Naphthylamine	Used only for research purposes	
Nickel	Oil combustion (including diesel fuel) Ferroalloys, iron and steel, and non-ferroalloy production Coal combustion Nickel matte refining Nickel mining and smelting Secondary nickel smelting Gray iron foundry Coke production/coke ovens Cement production Cooling towers Municipal and sewage sludge incinerators Electroplating Ni-Cd battery manufacturing	Gerstle, 1982 McCurley, et al., 1980 Radian, 1983d SAI, 1982
Nitrobenzene	End-use as solvent in cellulose ether manufacturing (petroleum industry) Nitrobenzene production and captive use to produce aniline	Dorigan, et al., 1976 SAI, 1982
N-Nitrosodimethylamine	N-Nitrosodimethylamine production Uses as intermediate in production of dimethyl formamide and dimethyl acetamide (industrial solvents), lauryl dimethylamine oxide, dimethyl hydrazine pesticides, and rubber chemical accelerators	SAI, 1982

Pollutants	Identified Emissions Sources[1]	References
Nitrosomorpholine	End-use as a corrosion inhibitor in boiler systems Polish and wax formulating Nitrosomorpholine production Production of rubber processing chemicals Manufacturing of optical brighteners (soap and detergent industry)	SAI, 1982
Parathon	Manufacturing, formulation, and application of parathion insecticide	Sittig, 1981
Phenol	Phenol production Production of phenolic resins Caprolactam and adipic acid production Bisphenol-A production Production of nonylphenol, salicylic acid, and dodecylphenol	SAI, 1982
Phosgene	Phosgene production Production of toluene diisocyanate, polymeric isocyanates, and polycarbonates	SAI, 1982
Polychlorinated biphenyls (PCBs)	Disposal by incineration or burning of transformers and capacitors containing PCBs Transformer leaks	Fuller, 1977 SAI, 1982
Polycyclic Organic Matter[4] (includes Benzo(a)pyrene)	Residential fuel combustion (primarily wood and coal)[5] Motor vehicles Prescribed burning and wildfires Municipal and industrial incineration[5] Coke production/coke ovens Other fuel combustion (burning coal refuse piles, power plants, industrial boilers, catalytic cracking Carbon black and charcoal production Asphalt production Dye pigment manufacturing	Archer, 1979d DeAngelis, 1980 Faoro, 1981 Kelly, 1983 Morales, 1979 Moscowitz, 1978 Murphy, 1981 Wainwright, 1982

Pollutants	Identified Emissions Sources[1]	References
Propylene oxide	Propylene oxide production Production of urethane polyols Production of surfactant polyols, propylene glycol, di- and tri-propylene glycols, and glycol ethers	SAI, 1982
Radionuclides	Fossil fuel combustion Uranium mining and processing Nuclear fuel fabrication, nuclear reactor operation, and spent fuel reprocessing Elemental phosphorous plants	Sittig, 1975
Tetrachloroethylene (Perchloroethylene)	Dry cleaning Textile processing and refinishing Metal cleaning and degreasing (solvent) Tetrachloroethylene production Miscellaneous chemicals production (intermediate) Miscellaneous solvent applications (magnetic tapes, plastics, rubber solutions, paint removers, inks, solvent soaps, fats, and oils)	Fishbein, 1979 Fuller, 1976 Sittig, 1981
Toluene	Automobile exhausts Manufacturing and application of paint and coatings Manufacturing and use of adhesives, inks, and pharmaceuticals Evaporation of gasoline Coke production/coke ovens Toluene production Benzene production Toluene diisocyanate production Benzoic acid production Production of vinyl toluene, benzyl chloride, xylene, p-cresol, and benzaldehyde	SAI, 1982 Walker, 1976b

Pollutants	Identified Emissions Sources[1]	References
1,1,1-Trichloroethane (Methyl chloroform)	Metal cleaning (degreasing) Various other solvent and cleaning applications End-use in aerosol formulations 1,1,1-Trichloroethane production Production of vinyl chlroide, vinylidene chloride and ethane	Fishbein, 1979 Oshmer, 1979 U.S. EPA, 1982c
Trichloroethylene	Metal degreasing (vapor degreasers and cold cleaners) Various other solvent and cleaning applications Trichloroethylene production PVC production	Fishbein, 1979 Oshmer, 1979 SAI, 1982 U.S. EPA, 1982c
Vinyl chloride	Vinyl chloride and PVC production Ethylene dichloride production	Sittig, 1981
Vinylidene chloride	Production of copolymer coating resins (saran, cellophane, latex) Manufacturing of modacrylic fibers Vinyldene chloride production Methyl chloroform production	Fishbein, 1979aa Hushon, 1978 Kelly, undated Tierney, 1979b
Xylene[6]	Mixed xylene solvent usage (primarily in paints and coatings) Automobile exhaust Gasoline evaporation Xylene production Terephthalic acid production	GCA, 1976e SAI, 1982

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[1] Listed in approximate decreasing order with respect to nationwide emissions.

[2] None found in literature specifically addressing emissions sources.

[3] Includes o-, m-, and p-cresol as well as cresylic acid.

[4] Polycyclic Organic Matter (POM) is also called Polycuclear Aromatic Hydrocarbons (PNA or PAH).

[5] The less efficient the combustion process, the more POM emissions may result.

[6] Includes o-, m-, p-xylene as well as mixtures of the three.

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